The European Union Policy of Zero Tolerance: Insights from the Discovery of CDC Triffid

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ABSTRACT

Flax is one of the major cash crops in Canada. Approximately seventy percent of Canadian flaxseed was exported to European Union (EU) annually until 2009. In 2009, the EU imposed an import ban on Canadian flaxseed due to the adventitious presence of a GM flax variety - CDC Triffid was identified in Canadian flaxseed exported to the EU. The EU's decision to apply zero tolerance on CDC Triffid flax has been based on its interpretation of the precautionary principle. According to the World Trade Organisation's Agreement on the Application of Sanitary and Phytosanitary Measures (SPS), however, precautionary measures are subject to a scientific risk assessment. As the EU did not base its zero tolerance for CDC Triffid flax on any scientific risk assessment, the EU is in violation of the SPS Agreement. Moreover, the EU has ignored the available scientific information regarding CDC Triffid flax. The EU did not consider the possibility of following the guidelines given by Codex Alimentarius Commission in the case of CDC Triffid flax. There are non-scientific reasons behind the EU's zero tolerance on CDC Triffid flax and they overweigh the available scientific information. The EU position would be unlikely to be supported if a complaint was brought to the World Trade Organisation Disputes Panel.

A partial equilibrium model was used to provide a theoretical background to examine the changes in the flaxseed industry and the linseed oil industry due to the CDC Triffid event. A model of the supply chain of Canadian flaxseed was developed to illustrate the operationalisation of the Protocol developed by the EU and Canada to address the zero tolerance policy. Empirical estimation suggests that the operationalisation of the Protocol incurred additional cost of $7.5 million to the flax seed industry of Canada in 2009/ 2010. Out of that, cost of testing was approximately $1.2 million and cost of segregation was $4.2 million.

Estimation of changes in revenue suggests that there was a loss of revenue in flaxseed trade between the EU and Canada in 2009/2010. Imports of Canadian flax by China provided an alternative market, at a considerably lower price than typically realised from the EU market. Interestingly, the EU's zero tolerance policy on CDC Triffid flax has resulted in a larger additional cost on the EU than Canada.

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ALA	=	Alpha Linolenic Acid
APHIS	=	Animal and Plant Health Inspection Service
BSP	=	Cartagena Protocol on Biosafety
CDC	=	Crop Development Centre
CFIA	=	Canadian Food Inspection Agency
CGC	=	Canadian Grain Commission
CRL-GMFF	=	Community Reference Laboratory for GM Food and Feed
DGSANCO	=	Directorate General for Health and Consumer Affairs
EFSA	=	European Food Safety Authority
EU	=	European Union
FAO	=	Food and Agriculture Organisation
FDA	=	Food and Drug Administration
GM	=	Genetically Modified
GMO	=	Genetically Modified Organisms
JRC	=	Joint Research Center
LLP	=	Low Level Presence
RASFF	=	Rapid Alert System for Food and Feed
SPS	=	Sanitary and Phytosanitary
WHO	=	World Health Organisation
WTO	=	World Trade Organisation
PPM	=	Process and Production Method
PND	=	Principle of Non-Discrimination
LMO	=	Living Modified Organisms
DSB	=	Dispute Settlement Body
PCR	=	Polymerase Chain Reaction

Chapter 1 : Introduction

1.1 Background

Cultivated flax (*Linum usitatissimum* L.) is of two types: one is grown for oilseed production and the other for fibre production. In Canada, only flax for oilseed is produced commercially. Flaxseed is used primarily in industrial applications but has secondary uses in animal feed and human food[1]. In recent years, flaxseed has become popular as a human nutritional oil seed because of its 'omega- 3 fatty acid' content.

Canada is the world's largest producer and exporter of flaxseed; sometimes called linseed. Flax is one of Canada's major cash-crops, alongside wheat, barley, oats, peas, lentils, soybean, corn and canola. In the 2008/2009 crop year Canada produced 861 000 tonnes of flaxseed and exported 639 000 tonnes out of that production (74%). The area harvested was 625 000 ha[2]. The export value of flaxseed was $319.5 million (Agriculture and Agri-food Canada, 2010) in 2009. Flaxseed accounted for nearly one percent of the agricultural export earnings of Canada in 2009[3] (Statistics Canada, 2010a). Canadian flax has been exported mainly to the European Union, the U.S., China and Japan**.**

1.2 Research Problem

The well developed Canadian flaxseed export market has faced a major challenge in the European Union (EU) since 2009. On September 8, 2009, the European Commission's Rapid Alert System for Food and Feed issued a notification that a commercial lab in Germany had

[1]The output of the crop is commonly known as "Flaxseed" which has a number of uses.

[2] Harvested areas of all wheat, barley and canola in 2008/2009 were 10 032 000 ha, 3 502 000 ha and 6 494 000 ha respectively (Agriculture and Agri-food Canada, 2010).

[3] Wheat (except Durum) accounts for nearly 12% of the agricultural export earnings while canola accounts for nearly 9% of the agricultural export earnings of Canada in 2009 (Statistics Canada, 2010a , Agriculture and Agri-food Canada, 2010).

detected the presence of unauthorised genetically modified[4] (GM) flax in a bakery product. The EU has a 'zero tolerance'[5] policy for products containing unauthorized genetically modified organisms (GMO). According to the Flax Council of Canada (2009a), the laboratories in the EU claim the GMO material is FP967[6], commonly known as CDC[7] Triffid, which was developed in Canada in late 1980s. CDC Triffid was registered by Canadian authorities for feed and environmental release in 1996 and for human consumption in 1999. CDC Triffid underwent a full food, feed and environmental risk assessment before licencing and was approved and authorized by Canadian and United States governments (Flax Council of Canada, 2009a). In 2001, however, it was deregistered due to fear of losing the main market for Canadian flax in the wake of the EU placing a moratorium on the import of GM crops in 1998.

The discovery of GM flax in September 2009 lead to widespread product recalls in the EU, quarantined shipments of flax from Canada, and a decline in prices received by Canadian flax farmers. Prior to the discovery of GM flax in the EU, approximately 70 percent of Canada's flax was exported to the EU and the loss of this major market represents a significant economic loss to Canadian flax growers. Under International Trade Law, to which both the EU and Canada subscribe, the basis of this market closure to Canadian flax by the EU is governed under the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) of the World Trade Organisation (WTO).

Concerns relating to the potential trade distortions created by domestic food safety regulations led to the establishment of SPS agreement of WTO (Issac, 2007). SPS measures are often put in place for legitimate reasons. They can, however, be used in nefarious ways for protectionist purposes in importing countries. Therefore, when developing international trade rules for the application of SPS barriers to trade, legitimate concerns should be the only basis. In the WTO's Uruguay Round it was agreed that science would be the sole criteria for the imposition of SPS

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[4] An organism, such as a plant, animal or bacterium, is considered as genetically modified if its genetic material (DNA) has been altered (CFIA, 2010).

[5] EU does not allow imported food and animal feed to contain GMOs that have not been authorised in the EU.

[6] CDC Triffid is referred by its experimental number 12115, its national field testing number FP967 or by its registered name CDC Triffid. These designations all refer to the same genotype of flax (McHughen et al, 1997).

[7] CDC refers to Crop Development Center of the University of Saskatchewan.

barriers. Since that time, it has become increasingly apparent that science is unable to effectively guarantee a sufficient degree of secure market access for agricultural exporters under the current international legal architecture (Smyth et al, 2011).

The recent import restriction on Canadian flax imposed by the EU is the latest manifestation of the non-efficacy of science-based criteria. Thus, is seems that after 15 years a review of scientific criteria as a basis for trade barriers is overdue. In future, major Canadian crops such as wheat are also vulnerable to similar regulatory failures/abuse as genetic engineering technology is applied to additional crops. According to Kerr (2003), science-based rules of trade have become a mantra for some. Also, they have become an anathema to others because such mechanisms produce undesirable outcomes from their perspective. Thus, beyond the issue of the use of biotechnology[8], there are a number of important issues pertaining to science-based rules of trade that warrant serious examination in the flax trade dispute.

'Zero tolerance' of CDC Triffid in the EU has created dramatic increases in the costs associated with flaxseed trade, reductions in producer prices and loss of processor and consumer access to this product in the EU. According to the Flax Council of Canada (2009a) no bulk handling system, no identity preserved system, no channeling system can manage the flow of exports to a level of zero tolerance. Furthermore, the EU closure of the Canadian flaxseed market through the ability to exploit the lack of transparency in the science-based rules of trade has induced some Canadian farmers to seek legislative actions to protect themselves. Controversial Bill C-474[9] is one example. It shows the loss of confidence in the WTO, and other international trade institutions, by farmers. Therefore, understanding the lack of efficacy of science-based trade rules and the impacts of such lack of efficacy are worthy topics for investigation.

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[8] Biotechnology refers to the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services (OECD, 1982).

[9] Bill C-474 requests an amendment to *Seed Regulations Act* of Canada to require an analysis of potential harm to export markets to be conducted before the sale of any new genetically engineered seed is permitted (Public Works and Government Services, 2009).

1.3 Research Objectives

Over the last fifteen years since science-based criteria were enshrined in the WTO, Western Canadian farmers have suffered considerable economic harm as a result of the poor structuring of scientific criteria in the SPS Agreement. This has led to questionable use of SPS rationales as justifications for the imposition of trade bans and restrictions. At present, Canadian flax farmers are facing a dilemma as to how to market their flaxseed in the face of the discovery of the adventitious presence[10] of GM flax in the EU market, which has been their major market for flaxseed. Hence, an examination of the operationalisation of zero tolerance is a necessary first step in improving the security of market access for Western Canadian farmers. In order to achieve that goal, this thesis has two objectives: (1) to examine whether the EU policies used to disrupt Canadian flax exports are compliant with the EU's SPS obligations; and (2) to estimate the additional costs and changes in revenue associated with the trade restrictions on Canadian flaxseed by the EU.

1.4 Outline of the thesis

This thesis is comprised of six chapters. The next chapter provides an analysis of the GMO policies of the EU. The chapter explains how GMO policies changed over time in the EU. It focuses primarily on the adventitious presence of unauthorised GMOs in food supply chains of the EU. Furthermore, Chapter Two explains the role of SPS Agreement in CDC Triffid flax incident. Chapter Three explains the EU's market restriction on Canadian flaxseed and the operationalisation of Protocol developed by Canada and EU. In addition, the chapter gives a theoretical explanation of changes in flaxseed market and linseed oil market after the CDC Triffid event. Chapter Four gives an overview of the flaxseed industry. The chapter explains the importance of export market to Canadian flaxseed industry. Chapter Five estimates the additional cost associated with the adventitious presence of CDC Triffid in the flaxseed supply chain. Chapter Six provides the summary and conclusions.

[10] Adventitious presence means the unintended, technically unavoidable presence of genetically engineered material in an Agri-food commodity (Agriculture and Agri-food Canada, 2007a).

Chapter 2 : GMO Policy of EU and the SPS Agreement

2.1 Introduction

Trade disputes arise when countries differ in their interpretations of their commitments made under international trade agreements. Both Canada and EU are members of the WTO and have made commitments under the WTO, and in particular the WTO's Agreement on Application of SPS Measures. They differ over their interpretation of the commitment to market access pertaining to the use of science in the decisions. One particularly contentious issue is market access for GMOs. The EU bans imports and sales of a large number of GMOs and their products while in Canada, a considerable proportion of the production of some crops, such as canola or soybeans, arise from the use of genetically modified seeds. Similar to Canada, a number of other countries are increasing their acreage under GM crops. According to ISAAA (2009), more than 77 percent of soybean, 49 percent of cotton, 26 percent of maize and 21 percent of canola and oilseed rape grown globally were genetically modified. Table 2.1 reports the global area of GM crops in 2009.

Table 2.1: Global area of GM crops in 2009: by major producing countries

Rank	Country	Area (million hectares)	GM crops
1	USA	64	Soybean, maize, cotton, canola, squash, papaya, alfalfa, sugar beet
2	Brazil	21.4	Soybean, maize, cotton
3	Argentina	21.3	Soybean, maize, cotton
4	India	8.4	Cotton
5	Canada	8.2	Canola, maize, soybean, sugar beet
6	China	3.7	Cotton, tomato, poplar, papaya, sweet pepper
7	Paraguay	2.2	Soybean
8	South Africa	2.1	Maize, soybean, cotton
9	Uruguay	0.8	Soybean, maize
10	Bolivia	0.8	Soybean

Source: (ISAAA, 2009)

The global area of GM crops in 2009 reached 134 million hectares. The annual growth rate is 7 percent. In contrast, the EU experienced a 12 percent (9796 ha) decrease of GM crop area from 2008 to 2009. In 2009, of the 27 countries in the European Union, only six countries officially planted GM maize on a commercial basis. The six EU countries which grew GM maize in 2009 were Spain, the Czech Republic, Portugal, Romania, Poland and Slovakia. In 2009, Germany discontinued planting GM crops. Spain was the largest EU grower of GM crop with 80 percent of the EU's total GM maize area and a adoption rate of 22 percent. The 2009 hectarege in the six EU countries was 94,750 hectares, i.e. 0.07 percent of the global area under GM crops (ISAAA, 2009). The only commercially cultivated GM crop in EU until 2010 was insect resistant Bt maize[11], which was approved in 1998. From 1999 to 2003 the EU had a moratorium on approving new varieties of GM crops. On March 13, 2010, the EU approved the first GM crop under its 2003 proceedings; GM potato EH92-527-1[12] for commercial cultivation (EC, 2010b).

As of January 2011, 39 GM foods and feeds are authorised to be used in EU (EC, 2010b). This chapter outlines the GMO import regulations in EU, and the role of international trade rules in the context of trade in GM crops. This discussion which is based on a review of the available literature, assists in understanding the present trade dispute between EU and Canada over the adventitious presence of GM flaxseed in conventional flaxseed export shipments. The zero tolerance policy of the EU regarding contamination of flax shipments has caused significant economic losses for the flaxseed industries in both Canada and the EU.

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[11] Bt maize contains a gene from the soil bacteria *Bacillus thuringiensis* that protects against the European corn borer, an important pest affecting maize crops.

[12] The genetically modified potato EH92-527-1, has an altered starch composition (higher amylopentin/amylase ratio).

2.2 EU GM policy

The first main legislation related to GMOs in EU was the Directive 90/220/EEC in 1990. The objective of this Directive was to approximate the laws, regulations and administrative provisions of the Member States and to protect human health and the environment when GMOs were being consumed or release into the ecosystems (EC, 2003). Two main areas were addressed in Directive 90/220. The first dealt with the deliberate release of GMOs into the environment. The second aspect concerned the placing of products containing, or consisting of, GMOs which were intended for subsequent deliberate release into the environment into the EU market (Belgiun Bio-safety Server, 1992).

Products derived from GMOs, such as paste or ketchup from a GM tomato were not covered by Directive 90/220/EEC but covered by the Regulation on Novel Foods and Novel Food Ingredients which was introduced on 27 January 1997 (Regulation (EC) 258/97) (EC, 2003). Directive 90/220/EC was replaced by Directive 2001/18/EC in 2001. As explained in EC (2010b), Directive 2001/18/EC introduced number of new requirements such as;

- *principles for environmental risk assessment,*
- *mandatory post-market monitoring requirements,*
- *mandatory information to the public,*
- *a requirement for Member States to ensure labelling and traceability at all stages of placing the product in the market,*
- *information to allow the identification and detection of GMOs to facilitate post-market inspection and control,*
- *first approvals for the release of GMOs to be limited to a maximum of ten years, the consultation of the Scientific Committee(s)/European Food Safety Authority (EFSA) to be obligatory, and*
- *an obligation to inform the European Parliament on decisions to authorise the release of GMOs and the possibility for the Council of Ministers to adopt or reject a Commission proposal for authorisation of a GMO by qualified majority, etc.*

Directive 2001/18/EC represents the present regulations pertaining to deliberate release of GMO into the environment (Europa, 2008).

The EU's present regulation for GM food and feed is Regulation (EC) No 1829/2003 (EU, 2003). Further, there are two amendments of that Regulation done in 2006 and 2008; Regulation

(EC) No 1981/2006 and Regulation (EC) No 298/2008. These regulations introduced a centralised procedure of authorisation of GM food and feed and also introduced rules for the labelling of GM food and feed and a threshold for the presence of GM material that is adventitious or technically unavoidable (EU, 2010a). The Regulation applies to three types of products:

- GMOs for food and feed use;
- food and feed containing GMOs; and
- food and feed produced from or containing ingredients produced from GMOs.

The authorisation procedure is explained through Articles 1 to 15, while regulation of labelling comes under Articles 17 to 23 of the Regulation (EC) No 1829/2003. Regulation (EC) No 1830/2003 also deals with the traceability and labelling of GMOs and traceability and labelling of food and feed products produced from GMOs (EU, 2003). Regulation (EC) No 1830/2003 was developed alongside Regulation (EC) No 1829/2003 and the two regulations are intended to operate in tandem and cross-rely on each other for certain requirements (EC, 2006). Additionally, a another legal instrument also plays a role in the marketing of GMOs within the EU namely, Regulation (EC) 178/2002, which lays down the general principles of food law, and establishes the European Food Safety Authority (EC, 2010c and EC, 2002).

In the case of Canadian flaxseed, while used primarily for industrial applications, it is also used as food and as feed in the EU. Therefore, the EU regulations related to food and feed are relevant to Canadian flaxseed used in the EU. In other words, regulations related to the deliberate release of GMOs into the environment are not considered in the case of CDC Trifid. Moreover, as there are only traces of GM flaxseed in shipments, the regulations related to the threshold for the presence of GM material that is adventitious or technically unavoidable are the most relevant for Canadian flaxseed imports in Europe. Therefore, this chapter focuses primarily on the EU regulations regarding adventitious or technically unavoidable presence of GMOs.

2.2.1 The EU threshold for adventitious presence of GMOs

There are two possible scenarios for the adventitious or technically unavoidable presence of GMOs in food or feed. The first is the presence of approved GMOs in non-GM food or feed. The second one is unapproved[13] GMOs in non-GM food or feed. At the international level, problems already exist in both scenarios because there is no consistent and harmonised set of rules to facilitate international trade in GM crops. In the United States, Canada, Japan, and Taiwan, food with a content of up to 5 percent of approved GM material can be classified as "non-GM;" however, in Australia, New Zealand, South Africa, Brazil, or China, all food with more than 1 percent of approved GM material has to be labelled as "GM" (Stein and Cereso, 2010). In the EU, the threshold[14] for adventitious or technically unavoidable presence of approved GMOs in food and feed is 0.9 percent, i.e. food and feed with more than 0.9 percent of approved GM material has to be labelled as "GM" (EC, 2006).

The basis upon which these thresholds were decided was the technically feasible level of detection of the GMOs in the non-GM material. For example, as explained by European Seed Association and European Association for Bioindustries (2007), in the production of conventional seed, visual detection is used to identify the adventitious presence of off-types. For example, in hybrid maize varieties, the documented average level of impurities detected visually over the past few years has been around 0.7 percent. However, with the development of modern molecular detection tools, specific known DNA sequences of GMOs can be identified at very low levels.

The real controversy arises when there is asynchronous authorisation for GMOs. Asynchronous authorisation occurs when a certain GM crop has been evaluated for its safety and authorised in the exporting country whereas the importing country has not authorised it. As explained by Magnier et al. (2009) asynchronicity has become a significant problem for broadly traded commodities. The main reason is perfect segregation of approved from unapproved GM crops is difficult within the global agricultural trade system. Comingling of a non-authorised GMO might

[13] Any product that has not received authorisation in a jurisdiction for import, food consumption, use as livestock feed, and/or environmental release (Agri-food Canada, CFIA, CGC, 2004).

[14] The minimum level of presence at which certain conditions apply; for example, declaration of presence on a label (Agri-food Canada, CFIA, CGC, 2004).

occur in conventional or other GM food as a result of adventitious or technically unavoidable presence during seed production, cultivation, harvest, transport or processing in the exporting country (Europa, 2010). Regulation 1829/2003 gave a threshold for the adventitious and technically unavoidable presence of GM material of non-authorised GMOs under the condition that a safety assessment had been carried out at EU level and that detection methods were publicly available. Under these conditions, material from these GMOs was tolerated up to 0.5 percent in food and feed. The reason for the transitional measure was to ensure a smooth transition to the new authorisation regime, i.e. Regulation 1829/2003, from the old authorisation regime; i.e. Regulation (EC) No 258/97 and Directive 2001/18/EC (EC, 2006).

This temporary threshold level however, expired in April 2007 bringing the level of tolerance to zero for all GM material not authorised in the EU (EC, 2008a). This is the main controversial point of the CDC Triffid flax event. As explained in Chapter 1, CDC Triffid flax was an authorised crop in Canada, but voluntarily withdrawn in 2001 and it is not authorised in the EU. Therefore, it creates an asynchronous authorisation situation and the EU has zero tolerance for the adventitious and technically unavoidable presence of CDC Triffid flax in conventional flaxseed. A zero presence of GMOs, however, is difficult to prove for exporters and therefore a testing Protocol is required to provide evidence that the requirement for zero has been met.

In the literature there are number of incidents that have already been reported under this low level presence (LLP) of unauthorised GMOs. As explained by Stein and Cereso (2010), currently there are about 30 commercial GM crops that are cultivated worldwide, the forecast is that by 2015 there will be more than 120. This may lead to a potential increase in the number of LLP incidents in GM crops worldwide. According to Backus et al (2008), it is likely that in the near future more trade problems will occur with the EU import of raw materials from exporting countries where more GMOs have already been approved or are under development. Therefore, the ‘zero-tolerance’ policy of EU towards LLP of unauthorised GMOs, is of growing concern due to its potential impact on international trade.

2.2.2 Incidents of LLP of unapproved GMOs in EU

There are number of documented cases where unapproved GM crops found their way into the food and feed supply chain: GM papaya, GM rice, GM corn, GM soybean, etc. Some of these incidents have led to significant economic losses for the exporting countries as well as for importers in the EU.

GM papaya

Unauthorised GM papaya[15] was found in imported papaya from Hawaii exported to one member state of EU in 2004. It was then notified to the other Member States via the Rapid Alert System for Food and Feed (RASFF). A specific detection method has been made available via the Joint Research Centre[16] of EC (EC, 2006; EC, 2005) to identify GM papaya. The Member State requested the Commission to impose emergency measures in accordance with Article 53 of Regulation (EC) N°178/2002. These measures are;

(i) suspension of imports of the food or feed in question from all or part of the third country concerned and, where applicable, from the third country of transit;

(ii) laying down special conditions for the food or feed in question from all or part of the third country concerned;

(iii) any other appropriate interim measure (EC, 2002).

The Commission concluded that an emergency measure according to Article 53 of Regulation (EC) N° 178/2002 can only be taken on the condition that it is evident that the food or feed in question is likely to constitute a serious risk to human health, animal health or the environment

[15] GM papaya has been developed to be resistant to papaya ring spot virus (PRSV) which is often a limiting factor in the production of papaya worldwide (Gonsalves, 2004).

[16] JRC provides the scientific advice and technical know-how to support a wide range of EU policies. The JRC has seven scientific institutes, located at five different sites in Belgium, Germany, Italy, the Netherlands and Spain, with a wide range of laboratories and research facilities (EC Joint Research Centre, 2010).

and GM papaya has not met that condition. However, papaya imported from Hawaii was detected by custom administration and imports contaminated with GM papaya were rejected. RASFF has not been notified of further discoveries of this unauthorised GM since 2005 (EC, 2006).

According to GMO Compass (2011), as of January 12, 2011 no application for approval of GM papaya in EU has been submitted. Therefore, importing and marketing GM papayas is not authorised in the EU. However, importation of GM papaya from Hawaii has been allowed in Canada since January 2003, and also allowed in Japan since 2010. The impression of the researcher who developed GM papaya, Dr. Dennis Gonsalves, shows his lack of confidence in GMO regulation in EU. *"Transgenic papaya will never win approval in EU, regardless of how much information is provided because the process is political in the EU[17]"* (Hawai'i Free Press, 2010). The GM papaya event also illustrates how anti-GMO groups like Greenpeace intervene at international level[18].

GM Rice

According to Brooks (2008), the operation of a zero tolerance policy for the LLP of unauthorised GMOs in the EU has already had a negative impact on the EU food sector. In particular, the rice sector of the EU has experienced a significant cost burden as a result of trace amounts of unauthorised GM rice LL601[19] being detected in long-grain rice in 2006. The EC adopted Decision 2006/578/EC regarding the GM rice LL601. According to that Decision, the use of the precautionary principle, as laid down in Article 7 of Regulation (EC) No 178/2002, was appropriate to prevent the placing of GM rice on the market (EU, 2006). The Decision 2006/578/EC requested an analytical report proving GM free rice (level of detection 0.01

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[17] All policy making is political, but in North America policy making over the GMOS's is mostly driven by science.

[18] An attempt to grow GM papaya in Thailand was stopped by Greenpeace by raiding a research trial where the transgenic papaya was growing. The plant material was destroyed (Hawai'i Free Press, 2010).

[19] LL601 is a GM rice variety, which was engineered by Bayer Crop Science to be tolerant to herbicides marketed under the brand name LibertyLink (USDA, 2006).

percent) be issued by an accredited laboratory which conformed to internationally recognised standards (EC Joint Research Center, 2006). This can be considered a similar situation to that of CDC Triffid flax.

Brooks (2008) has given the costs of this zero tolerance for the presence of unapproved GM rice LL601 in the supply chain of the EU since 2006. At the company level (rice miller), the average cost of dealing with LLP of unapproved LL601 has been between €3.5 million and €7.4 million and at the industry level (across about 15 rice millers), the cost, as of early 2008, was between €52 million and €111 million. These costs were equivalent to between 6 percent and 13 percent of the total value of the EU long grain rice market in 2008. The costs include the cost of testing, cost of product withdrawal from the market, legal costs, adverse impact on brands and product/company image, claims for compensation from customers not covered by insurance, financial charges, staff time spent on dealing with the event, loss of sales and profits, etc. In the present study legal costs, adverse impact on brands and product/company image associated with EU's zero tolerance of CDC Triffid flax was not estimated.

It is interesting to note the scientific support of the European Food Safety Authority (EFSA) regarding the LLP of GM rice LL601 given in September 2006. In their risk assessment report, the EFSA mentioned that the available information was not sufficient to complete a comprehensive risk assessment, however, on the basis of available information, they concluded that the consumption of imported long grain rice containing trace levels of LL601 is not likely to pose an imminent safety concern to humans or animals (EC, 2006).

Moreover, on November 2006, the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) also announced that after a thorough review of the scientific evidence it will deregulate GM rice LL601 based on the finding that it is as safe as its traditionally bred counterparts. The U.S. Food and Drug Administration (FDA) concluded that the presence of GM rice LL601 in the food and feed supply poses no safety concerns (USDA, 2006).

As of March 2010, no application had been made for authorisation of GM rice LL601 in the EU. However, in 2010 the European Commission forwarded a proposal to Member States to lift emergency measures for GM rice LL601. Meanwhile, Member States continue to check for traces of GM rice LL601 (EC, 2010d).

GM Soybean

GM soybean provides a good case study with which to examine the zero tolerance policy of EU. The EU livestock industry is highly dependent on soybeans as a main source of protein in feed. Approximately 75 percent of soy used in the feed industry in EU is imported, mostly from the US, Argentina and Brazil (Aramyan et al., 2009). Over the last few years, however, the EU has faced difficulties with the import of soybeans for animal feed from major exporting countries due to the zero tolerance policy. Aramyan et al. (2009) predict that with the expanding international cultivation of GM varieties, potential trade disruptions could become more severe and more frequent. Therefore, the authors suggest the relaxing of the zero-tolerance policy for unapproved GM-soybean varieties to an alternative tolerance threshold that might prevent the decline of imports and the problems associated with it.

The EU soybean sector experienced market disruption due to incidents of LLP of GMOs in 2008 and the cost of such events is estimated to be between €1 billion and €2.8 billion (Brooks, 2008). According to Backus et al. (2008), in 1996 the US was the largest supplier of soybeans to the EU (9.4 million tonnes), but in 2006 its exports has decreased to 3.4 million tonnes (22 percent of total imports) mainly because of LLP of unauthorised GM events. By 2006, Brazil became the largest source of soybeans for the EU, with a market share of 62 percent (9.7 million tonnes)[20]. Backus et al. (2008) assume that problems will be more severe when Brazil adopts the next generation of GM soybeans. Currently three GM soybean varieties are approved in the EU. Approved varieties are MON40-3-2, MON89788 and A2704-12. The tendency of the EU in approving GM soybean is quite understandable because 77 percent of world soybean production is genetically modified.

[20] Part of this increase in the presence of Brazilian product in the EU can, however, be attributed to the increased international economic competitiveness of Brazil's producers.

GM corn

In 2005, it was found that US exports of maize products to the EU was contaminated with unauthorised GM maize Bt10[21]. As a result, the European Commission, with the support of Member States, adopted Decision 2005/317/EC and this Decision lays down the condition that all the maize products originating from the US have to be accompanied by a report of analysis demonstrating the absence of the unauthorised GM maize before being placed on the EU market (EC, 2006). This is similar to the 'Protocol' developed for CDC Triffid flax.

According to GM Compass (2010a), GM maize variety MON88017[22] was not authorised in the EU until 2009, even though it has been found not to pose an unacceptable risk by EFSA. Therefore, comingling of this unauthorised GM maize in US soybean shipments resulted in rejecting of US soy shipments by the EU. However, this incident created an animal feed shortage in the EU. GM maize MON88017, has been authorised for cultivation in the US since 2005. In 2005, the US applied for approval for exporting MON88017 for food and feed to the EU. In April 2009, the EFSA issued its risk assessment opinion classifying MON88017 maize as harmless (EFSA, 2009). Based on that assessment, the European Commission prepared a proposal for granting authorisation, but this did not receive the support of Member States (GMO Compass, 2010a). This incident can be considered as one of the major draw backs faced by the EU due to its zero tolerance policy. However, in October 2009, the European Commission granted the authorisation for import of MON88017 in the EU until 2019 (EC, 2009a).

GA-21 corn

Between April 2007 and March 2008 maize exports from Argentina to the EU were temporarily suspended due to the LLP of an unauthorised GA-21 maize event. GA-21 maize was not

[21] Bt10 is a GM maize line, developed in the 1990s by the company Syngenta together with Bt11 maize. Bt10 maize is resistant to the European corn borer. Further development of Bt10 has been discontinued prior to reaching the stage of regulatory approval. The accidental release occurred because some batches of Bt10 were erroneously labelled as Bt11 (EC, 2006).

[22] MON88017 maize is resistant to the European corn borer and is also herbicide-tolerant.

authorised for use in feed in the EU. The import ban for Argentinean maize resulted in a price increase for non-GM maize. Normally, the premium for non-GM maize is US$50 per tonne but between April 2007 and May 2008 it was US$80-100 per tonne (Backus et al., 2008). However, as of March 28, 2008, GA-21 corn has been authorised under the European Commission Decision (2008/280/EC).

2.2.3 Challenges to EU's 'zero tolerance policy'

The zero tolerance policy of the EU for unauthorised GMOs has been challenged in EU when the European Commission's Directorate-General for Agriculture and Rural Development published a report in June 2007 declaring that the EU's zero tolerance policy and asynchronous approvals would have negative impacts on the European pork and poultry sectors (EC, Directorate-General for Agriculture and Rural Development, 2007). The European biotechnology industry and the animal feed industry are also claiming that the EU's GMO policy is harming the EU livestock industry. Another major challenge to zero tolerance policy was the detection of non authorised MON88017 maize in soybean shipments from the US in 2009 (Friends of Earth Europe, 2010a). As the EU's livestock industry heavily depends on soybean imports from the US, this incident led to an animal feed crisis in EU. As explained by Gruere (2009), asynchronous approval of GMOs is likely to contribute to overall inflation in food prices in the EU.

In July 2008, the WHO/FAO Codex Alimentarius Commission adopted new set of simplified risk assessment guidelines for the temporary approval in cases of low level presence of (LLP) of GM products when there is asynchronous authorisation (Codex Alimentarius Commission, 2009). In these guidelines the Codex Alimentarius Commission mentioned that commingling of commodities from storage, export and processing would mean only low levels of GMOs in individual servings of food. These new guidelines, which are explained under the Codex's Annex 3, signals the international concern pertaining to the commercial reality of traces of GM products in non-GM products worldwide. According to Gruere (2009), the need to find practical regulatory mechanisms to solve this issue has lead over 160 members of the Codex Alimentarius to adopt the new standard despite dramatic country differences on many aspects related to the regulation of GM food. In comparison, Gruere (2009) reports that the discussions at the Codex Alimentarius Committee on GM food labelling have not led to agreement 16 years after it was first introduced.

Due to the technical and commercial infeasibility of a zero tolerance policy, on October 29, 2010 the European Commission presented a recommendation for a tolerable threshold of unapproved GMOs in agricultural imports. According to those recommendations, in the future unintentional impurities should be permitted up to 0.1 percent only for feed. The tolerable threshold for food is zero. However, the GM food producing countries, including the US, Canada, Brazil and Argentina, are not happy about the dividing line between food and feed and they argue it would lead to "insurmountable difficulties in agricultural trade" (GMO Compass, 2010b). Further, all the Member States of the EU must agree with this recommendation in order to have it become a regulation.

Furthermore, in July 2010, the European Commission recommended that member states have greater freedom when deciding whether or not to allow the growing of genetically engineered crops in their domestic markets (ICTSD, 2010). The Commission proposed this controversial change as a solution to present GMO policy which has divided the EU member states for more than a decade.

2.3 Zero tolerance policy and SPS agreements

To explain the zero tolerance policy of the EU, in the context of international trade the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity (Biosafety Protocol) are the most relevant international institutional arrangements.

The SPS Agreement creates disciplines applicable to measures for the protection of human and animal life or health (sanitary measures) and of plant life or health (phytosanitary measures) from certain, defined risks (UN, 2003). According to the definition of an SPS measure, the agreement applies to measures taken; "*to protect human or animal life from risks arising from additives, contaminants, toxins or disease-causing organisms in their food, beverages, feedstuffs;*

to protect human life from plant or animal carried diseases (zoonotics); to protect animal or plant life from pests, diseases, or disease-causing organisms; to protect a country from damage caused by the entry, establishment or spread of pests" (WTO, 2010a).

These measures allow Members of the WTO to violate the principle of non-discrimination (PND) which may be thought of as the baseline principle of the international trading system that all domestic market access rules must meet (Isaac et al., 2002). The first and second provisions of PND state that foreign products must be treated like domestic products and there should be no discrimination between products originating from different countries. However, under the SPS Agreement, Members may discriminate against imports because of the presence of risks to human, animal or plant health. In other words, Members are not required to grant either national treatment or most-favoured nation status to agricultural exporters whose products risk contaminating the domestic food supply or the environment (Isaac et al., 2002). The third provision of PND seems controversial in the case of biotechnology. It states that all 'like products' are to be treated the same regardless of the process and production method (PPM) used in their manufacture. According to that provision, the international trading system has to deal with market access of products created by biotechnology, but not with the process of biotechnology. It is only if the GM product is physically different from the non-GM product that a trade measure can be justified. Thus, as it is not possible to discern the difference between a shirt made using GM cotton and a shirt made with non-GM cotton, a trade barrier cannot be put in place against shirts made with GM cotton. The use of biotechnology is a PPM and, hence, trade barriers should not be allowed on the basis of a product being GM. The Biosafety Protocol, on the other hand, considers biotechnology as an unlike product where trade barriers can be imposed based on technology used.

The SPS Agreement considers science as the criterion upon which SPS measures will be evaluated. In other words, SPS measures must be based on scientific principles and not be maintained without sufficient scientific evidence except as provided for in Article 5.7.

Article 2.2 of the SPS states that: *"Members shall ensure that any sanitary or phytosanitary measure is applied only to the extent necessary to protect human, animal or plant life or health, is based on scientific principles and is not maintained without sufficient scientific evidence, except as provided for in paragraph 7 of Article 5."*

Therefore, it is apparent that while the SPS Agreement acknowledges the right of countries to take measures to protect human, animal or plant life or health, it also expects such measures may only be in place if they are based on “scientific principles” and are not maintained “without sufficient scientific evidence”. There are two options for countries to show their measures are based on science. The first one is to base their measures on international standards and the second one is to base them on a scientific risk assessment.

Article 5.7 of the SPS states that: *In cases where relevant scientific evidence is insufficient, Member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information, including that from the relevant international organisations as well as from sanitary or phytosanitary measures applied by other Members. In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the sanitary or phytosanitary measure accordingly within a reasonable period of time.*

Therefore, according to Article 5.7 of the SPS Agreement, Members have a right to establish provisional SPS measures (trade restrictions) based on precaution, if there is not sufficient scientific evidence to conduct an appropriate risk assessment (Isaac et al., 2002). This use of ‘Precautionary Principle’ has become one of the most controversial points in the case of trade conflicts related to GMOs.

According to the EC (2010b), the regulatory framework for GMOs in the EU takes account of the requirements of the Cartagena Protocol on Biosafety (BSP), and also is in line with WTO rules. Therefore, understanding the BSP is also important in analysing the EU regulation of GMOs. The BSP sets rules for international trade in living modified organisms (LMOs). LMOs are basically GMOs that have not been processed, and that could live if introduced into the environment, such as seeds. Karlson (2008) explains the difference in precautionary approach of BSP and that of SPS Agreement. Articles 10.6 and 11.8 of the BSP state that:

Article 10.6*:“Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity in the Party of import, taking also into account risks to human health, shall not prevent that Party from taking a decision, as* *appropriate, with regard to the import of the living modified organism in question as referred to in paragraph 3 above, in order to avoid or minimise such potential adverse effects."*

Article 11.8: "*Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity in the Party of import, taking also into account risks to human health, shall not prevent that Party from taking a decision, as appropriate, with regard to the import of that living modified organism intended for direct use as food or feed, or for processing, in order to avoid or minimise such potential adverse effects"*(Convention of Biological Diversity, 2011).

Karlson (2008), argues that according to the rules in the BSP, the importing country has complete authority over the review of its decision and exporters have no means to overturn it, no matter what reasoning is used to justify the restrictive measure. In addition, there is no requirement for the importing country to seek the information necessary to reach scientific certainty, so a trade-restrictive measure may be in force without time limits. However, as explained by Hobbs et al. (2005), major producers and exporters of agricultural crops based on biotechnology (e.g. the US, Canada, China and Argentina) have not ratified the BSP and it will become a failed multilateral environment agreement and potentially evolve into a protectionist club. The WTO remains the only multilateral organisation to encompass most of the GM producing and potential importing countries.

As explained by Isacc et al. (2002) Canada is a member of WTO and a BSP signatory but it has not ratified the BSP. For Canada, the WTO rules should apply. Therefore, in the case of the CDC Triffid event, international trade based on WTO rules is valid for Canada, not those of the BSP. Section 2.3.1 explores trade disputes related to the SPS Agreement of WTO.

2.3.1 Trade disputes related to SPS Agreement

According to the WTO (2010a), Canada has been party to 33 complaints brought to the WTO Dispute Settlement Body (DSB). Out of those complaints, 15 cases were against US and nine cases were against the EU. Out of nine complaints against EU, three were based on violation of the SPS Agreement. Out of those three complains, one is related to export of biotechnology products to the EU.

In 2003, Canada claimed (case number DS292) that the moratorium on the approval of biotechnology products applied by the EU since October 1998 had unfairly restricted imports of agricultural and food products from Canada (WTO, 2010c). The US and Argentina also made the same complains against the EU (Case numbers are DS291 and DS293 respectively). According to Smyth et al. (2006) Canada's share of the EU canola imports fell from 14 percent in 1990-1996 to 2 percent in 1997-2003. The EU, however, denied the existence of such a moratorium. According to Canada, the measures at issue appeared to be inconsistent with the EU's obligations under: Articles 2.2, 2.3, 5.1, 5.5, 5.6, 7 and 8, and Annexes B and C of the SPS Agreement (WTO, 2010c).

The Dispute Settlement Body (DSB) established a single Panel to examine this dispute. After a very lengthy procedure, in 2006 the Panel found that the EU applied a general de facto moratorium on the approval of biotechnology products between June 1999 and August 2003. Furthermore, the panel found that, by applying this general moratorium, and taking measures related to the approval of specific biotechnology products, the EU had acted inconsistently with its obligations under the SPS Agreement (WTO, 2010c). With regard to the prohibiting the import/marketing of specific biotechnology products by Member States, the Panel found that the EU acted inconsistently with its obligations under Articles 5.1 and 2.2 of the SPS Agreement. The main reason given was that those measures were not based on a risk assessment as required under Art. 5.1 and defined in Annex A(4). In 2009, Canada and the EU agreed to establish mutually agreed solution to this trade dispute (WTO, 2010c).

The other main trade dispute related to the SPS Agreement is the dispute regarding imports of beef produced using growth hormones. The EU's ban on the importation of livestock and meat from livestock that have been treated with hormones were opposed by both US and Canada. In 1996, Canada requested consultations with the EU regarding this ban. The Canadian claim was the same as the US claim (WT/DS26), for which a Panel had been established. The Panel found that the EU ban on imports of meat and meat products from cattle treated with any of six specific hormones for growth promotion purposes was inconsistent with Articles 3.1, 5.1 and 5.5 of the SPS Agreement (WTO, 2010b).

However, in 1997, based on the appeal of the EU, the Appellate Body of the WTO dispute settlement system found that the EU import prohibition was inconsistent with Articles 3.3 and 5.1 of the SPS Agreement. A major part of the finding of the Appellate Body was that the EU had not carried out an adequate risk assessment. The EU was asked to open its market to beef produced using hormones, but it failed to comply. Canada and the US were in the position to retaliate. In 1999, Canada, requested authorisation from the DSB for the suspension of concessions to the EU in the amount of CAN$75 million. The arbitrators determined the level of nullification suffered by Canada to be equal to CDN$11.3 million annually. The DSB permitted the imposition of retaliatory duties against the EU by Canada in 1999 (WTO, 2010b). The US has also been permitted to suspend tariff concessions to the value of US$116.8 million per year. This became the first commercial dispute settled by the WTO under the SPS Agreement.

After Canada's retaliation under the DSB, the EU initiated 17 scientific studies to assess the safety of the hormones concerned. On the basis of these Opinions, in 2005, the EU initiated new WTO dispute settlement proceedings against Canada (as well as the US). After lengthy proceedings, the WTO panel reported that the EU ban was inconsistent with the WTO rules, but also found Canada to be in violation of certain procedural issues[23] (Foreign Affairs and International Trade Canada, 2008).

On May 29, 2008, the EU filed a Notice of Appeal of the report of WTO panel. The Appellate Body found that Canada is not in violation of any WTO obligations by imposing retaliatory duties against the EU. Their report also expressed concern with the EU's failure to comply with the recommendations and rulings of the DSB. It further confirmed that the DSB's recommendations and rulings in the original EU-Hormones dispute remain operative and binding on the EU (Foreign Affairs and International Trade Canada, 2008). Following a series of negotiations, the United States and the EU and Canada and the EU have separately agreed to settlements that could resolve this long-standing trade dispute. However, the EU market remains closed to beef produced using hormones.

[23] WTO panel found that Canada was in violation of WTO obligations by unilaterally determining Directive 2003/74/EC is WTO inconsistent.

There have been approximately 37 trade disputes over SPS measures other than two disputes mentioned above (WTO, 2010a). Controversial disputes include the dispute between the US and Japan over Japan's phytosanitary measures on imports of US apples, the dispute between Canada and Australia over Australia's ban on imports of Canadian fresh, chilled and frosen salmon and the dispute between Canada and South Korea over South Korea's measures on imports of bovine meat and meat products from Canada, etc. Most of the disputes were based on violations of Article 2 and Article 5. Article 2 pertains to scientific principles and Article 5 pertains to risk assessments. Therefore, it is apparent that taking SPS measures based on scientific principles and proving there is a risk using a risk assessment were the most commonly violated parts of the SPS Agreement. As explained by Kerr (2003), in order to put in place measures justified on SPS grounds, a country should prove that there is a scientific reason for the trade restriction and also there should be a risk related to imports of the restricted products. If the identified scientific problem does not pose a risk it cannot be used as a reason to impose a trade barrier. In the case of CDC Triffid flax the EU's trade restriction can be considered as an invocation of the precautionary principle. Therefore, understanding the scientific rationale behind the precautionary principle is important in analysing the EU's zero tolerance policy on CDC Triffid flax. Section 2.4 examines the precautionary principle as a justification for the zero tolerance policy of the EU.

2.4 The precautionary principle

According to Giampiatro (2002), the trade dispute between the EU and the US over GMOs is putting the precautionary principle onto the political agenda of both parties. Within the EU, the precautionary principle is generating disagreements between the Commission and individual member states. As explained by Sandin (2005), the precautionary principle has critics, and it has been subject to severe suspicion and disagreement. One objection is that the precautionary principle is ill defined, and therefore it can be used to ban anything. Another objection is that the precautionary principle allows science only a marginalised role in decision making. In the Communication published in 2000, the EU defines the precautionary principle as follows.

> *"The Precautionary Principle covers those specific circumstances where scientific evidence is insufficient, inconclusive or uncertain and there are indications through preliminary objective scientific evaluation that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the chosen level of protection"* (European Commission 2000, p. 10).

This can be considered as an important point in the case of CDC Triffid flax. Even though there was enough scientific evidence to satisfy Canadian regulations that CDC Triffid flax would not pose potentially dangerous effects on environment, human, animal or plant health, the EU can still consider that the existing evidence is not sufficient, inconclusive or uncertain. This creates an interesting problem of what is the threshold of scientific evidence to be considered safe by the EU. Van den Belt (2003) analysed the precautionary principle and argued that proving absolute safety in innovations is a logically impossible task. According to Van den Belt, the proponents of precautionary principle consider 'sound science' is represented by 'fully quantified risk assessment' which proves no possible harm from an innovation. In the case of GMOs, however, where indirect, cumulative effects are possible, fully quantified risk assessment is an unattainable task. In other words, proving a negative is impossible. It is also interesting to see that the EU acknowledge that zero risk is not possible.

> *"The measures envisaged must make it possible to achieve the appropriate level of protection. Measures based on the precautionary principle must not be disproportionate to the desired level of protection and must not aim at zero risk, something which rarely exists"* (European Commission, 2000).

In the case of CDC Triffid, however, the EU expects to have no possible risk or zero risk by maintaining a zero tolerance policy, which is an unattainable objective. It is apparent that the precautionary principle, which is the basis of zero tolerance policy, is linked with a number of other factors which give very vague definitions in different situations. Section 2.5 focuses on some of the factors influencing zero tolerance policy other than scientific risk.

2.5 Factors other than scientific risk behind the EU's GMO policy

The insignificant area under GM crops in the EU indicates that the process of approving such crops in the EU is politicised. This has made the regulations very complex. According to Backus et al. (2008) the slower rate of cultivation of GM crops in the EU, as compared to other countries, is due to consumer resistance to GMOs and the lengthy procedure of the EU for approving new GM crops. The draft Commission Decision authorising the placing on the market of products containing, consisting of, or produced from genetically modified maize MON89034 clearly shows how other factors outweigh science in authorising GM crops in the EU (EC, 2010e). Even after EFSA gave a favourable opinion, Member States did not support the decision based on the following reasons:

- *the European Food Safety Authority (EFSA) opinion was not considered as fully satisfactory;*
- *the precautionary principle was invoked;*
- *the negative public opinion with respect to GMO;and*
- *political reasons (*EC, 2010e).

This shows that science is a criteria the EU uses when determining the market access for GM crops, but it is not the only criteria. Therefore, scientific evidence does not guarantee market access into the EU for any particular GM crop if the other reasons mentioned above are more influential.

Tiberghien (2009) has explained the reasons behind the highly restrictive regulatory position of the EU in adopting GMOs. The author advances a framework of competitive governance in the EU. This competitive governance leads to disagreements in legitimacy and agenda setting between the Commission and the Council of Ministers on highly controversial issues. In the case of GMOs, the multi-level nature of EU governance creates a challenge of legitimacy. This was clearly highlighted in the speech titled "GMOs: Letting the Voice of Science Speak" given at a Policy Dialogue at European Policy Centre in Brussels on October 15, 2009. The speaker was Mariann Fischer Boel, a Member of the European Commission responsible for Agriculture and Rural Development.

> "*Month after month, GMOs receive a clean bill of health from EFSA, but then get stuck because Member States cannot reach any qualified majority, in favour or against, when it comes to the vote on a proposal for authorisation. So first the relevant committee decides nothing; then the Council decides nothing; and finally, the Commission grants authorisation, as laid down in the rules. This process swallows huge amounts of time. That would be quite legitimate – necessary, in fact – if new scientific information was being put on the table. But in the vast majority of cases, this is not what's happening*" (Europa, 2009).

Therefore, the perceived gap between policy decisions and the low level of trust toward available scientific information on food safety have led to more restrictive regulation on GMOs in the EU. Another possible explanation given by Jackson and Anderson (2005) is that the EU is giving EU biotechnology firms time to catch up with American competitors so that intellectual property rights will be paid to domestic rather than foreign patent holders. Further, they suggest that the EU moratorium on GM imports helps the EU farmers even though it negates the productivity they could receive from the new GM biotechnology. Both arguments can be considered as examples of pure economic protectionism.

According to Prévost (2010), the EU regulators are faced with pressure from lobby groups who represent agricultural interest that are becoming less competitive in agriculture due to progress in trade liberalisation. The author argues that when the Agreement on Agriculture was signed in 1995 at the Uruguay Round Negotiations, the protected agriculture sector of the EU was exposed to liberalisation. The Agreement on Agriculture was aimed at dismantling the traditional protectionist measures such as tariffs, export subsidies and domestic supports which were the shields that protected domestic producers in the EU from competition. Therefore, the agricultural industry in the EU tends to seek protectionism in the form of non-tariff barriers such as SPS barriers (Prévost, 2010). This can be considered as a nefarious use of SPS measures to provide economic protectionism to producers.

In the case of the GMO debate within the EU, a number of influential interest groups can be identified. Out of these groups, Friends of Earth Europe, Greenpeace and European Farmers Coordination have jointly lobbied various levels of the government to support the EU's zero tolerance policy. They argue that the reason for food and feed prices reaching crisis levels in EU in 2007-2008 was not an outcome of EU's 'zero tolerance policy' on GMOs. They do not explain the possible reasons, but assumes that the rejected amounts of food and feed due to GM contaminations were too low to create a food and feed crisis in the EU (Friends of Earth Europe, 2010a). Further, they have challenged European Commissions recent proposal to change legislation on GM food and feed. For example,

> *"The European Commission is bowing to the scaremongering tactics of the biotech industry, and as a result, opening Europe's markets to unauthorised GM food and feed. Europe's laws on genetically modified foods are there for a reason – to protect the public and the environment. The right of the public to say no to GM foods and feeds must be respected. Member states should reject this proposal and maintain Europe's position on zero tolerance."* (Friends of Earth Europe, 2010b).

According to Maginier et al. (2009), the EU's organic producers also strongly oppose the introduction of allowances for low level adventitious presence of unapproved GM crops in the agricultural supply chain. The main reason for the opposition is the increase in profits of these non-GM producers in the presence of trade restrictions on unapproved GM crops.

As explained by Hobbs et al. (2004), the inability of consumers or downstream firms to detect the presence of GMOs leads to the problem of asymmetric information and uncertainty. In such situations, individuals may assign vastly different subjective probabilities to various outcomes. Similarly, consumer lack of awareness of whether there is any risk in CDC Triffid flax may also leads to the problem of asymmetric information and uncertainty. Hobbs et al. (2004) also emphasize the potential of consumer demanding for protectionism. This is particularly relevant in the case of CDC Triffid flax. Even though only fifteen to twenty percent of flaxseed imports of EU is destined for direct human consumption, consumer demand for protection from GM flaxseed can be considered as one of the reasons for imposing the trade restriction on Canadian flaxseed. It is apparent that consumer views, concerns and perceptions are very important in trade of any commodity. However in the case of CDC Triffid flax, absolute risk averseness of consumers is an irrational behaviour as CDC Triffid flax poses no significant threat to their health.

Eurobarometer surveys measures the attitudes and perceptions of a representative sample of the adult population of each Member State of the EU. A survey conducted in 2005, shows that public trust is still lacking for allowing GMOs to be used in products destined for human consumption.

A majority of Europeans (58 percent) believe that the development of GM foods should not be encouraged (EC, 2008b).

According to Josling and Roberts (2001), consumer resistance to GMOs in EU is linked to a scare surrounding the illegal use of diethylstilbestrol (DES) in veal production in France in 1970. DES was found in baby food made from veal, and cases of children born with birth defects due to exposure to DES were reported in EU. The DES scare in EU created a consumer suspicious of the harmful effects of certain food production practices. This suspicious surfaced in the wake of the outbreak of bovine spongiform encephalopathy (BSE), the ban on the use of hormones in livestock production and, more recently, with the introduction of GMOs into the food chain.

Decisions based on inaccurate testing methods are also used as a justification for trade restriction on Canadian flaxseed. Extremely sensitive testing methods lead to number of false positive test results along the supply chain. Based on inaccurate testing results, consumers tend to think that the comingling is widespread. This bias in testing has created increased suspicion among consumers and the costly initiatives for the flaxseed industry to deal with them. According to European Commission Joint Research Center (2009b), a company named Genetic ID NA, Inc developed the technique for detecting CDC Triffid i.e. the ‘NOS-spec. Construct Specific Real Time Polymerase Chain Reaction Method (PCR)’. This method was then transferred to the Community Reference Laboratary for Food and Feed (CRL-GMFF) of the European Commission Joint Research Center by German authorities.

According to Gryson et al. (2007), PCR method is well known for its high sensitivity and specificity, however acquisition of reliable results might be negatively influenced by the presence of PCR inhibitors and the deterioration of DNA through the processing of the product. According to Booker (2011), CDC Triffid contamination in breeder seed lots ranged between 2 GM seeds per million and 6 seeds per hundred thousand. Due to this low level presence of GM seeds, the number of positive tests expected from a clean seed lot is indistinguishable from the potential rates of false positive tests. Also, as the seed lots are tested repeatedly along the supply chain, these errors will likely produce a substantial number of contradictory results with clean seed lots tending to be rejected. Based on the false positive rate of 0.006, Booker (2011) has estimated that 2.4% of clean seed lots will have at least one false positive test out of four and this probability expands considerably as the number of tests per lot increase.

According to above mentioned reasons, it is apparent that scientific reasons are not the only reasons behind EU's GMO policy. The SPS Agreement, however, expects Members to rely on science whenever they use SPS measures. Therefore, it is important to understand how the precautionary principle is treated in the context of WTO rulings. Moreover, it is also important to analyse whether the EU met its commitment in the SPS Agreement in the case of the CDC Triffid flax event. This question is the focus of section 2.6.

2.6 The Precautionary principle and WTO rulings

According to Kogan (2006), the decision of WTO panel on *EC Biotech Products* (DS 292) is especially significant for its discussion of the Precautionary Principle's legal status. The WTO Panel's decision on Biotechnology Products makes clear that in the absence of relevant international standards, WTO members should conduct a scientific risk assessment. Furthermore, the Panel determined that the phrase 'insufficient scientific evidence' of Article 5.7 does not permit WTO members to override the SPS Article 5.1 which requires an adequate science based risk assessment (Kogan, 2006; Zarrilli, 2005).

The WTO Appellate Body in *Japan - Agricultural Products* (DS 76),[24] identified four requirements for provisional measures under Article 5.7.

> *The measure must:*
> *(1) be imposed in respect of a situation where "relevant scientific information is insufficient";*
> *(2) be adopted "on the basis of available pertinent information";*
> *(3) not be maintained unless the Member seeks to "obtain the additional information necessary or a more objective assessment of risk"; and*
> *(4) be reviewed accordingly "within a reasonable period of time".*

[24] Japan bans the importation of eight agricultural products; apples, cherries, walnuts, apricots, pears, plums and quince originating from the United States on the ground that they are potential hosts of codling moth, a pest of quarantine significance to Japan (WTO, 1999). The ban was in place from the early 1970s to 2001. In 2001 Japan and the US found a mutually acceptable solution.

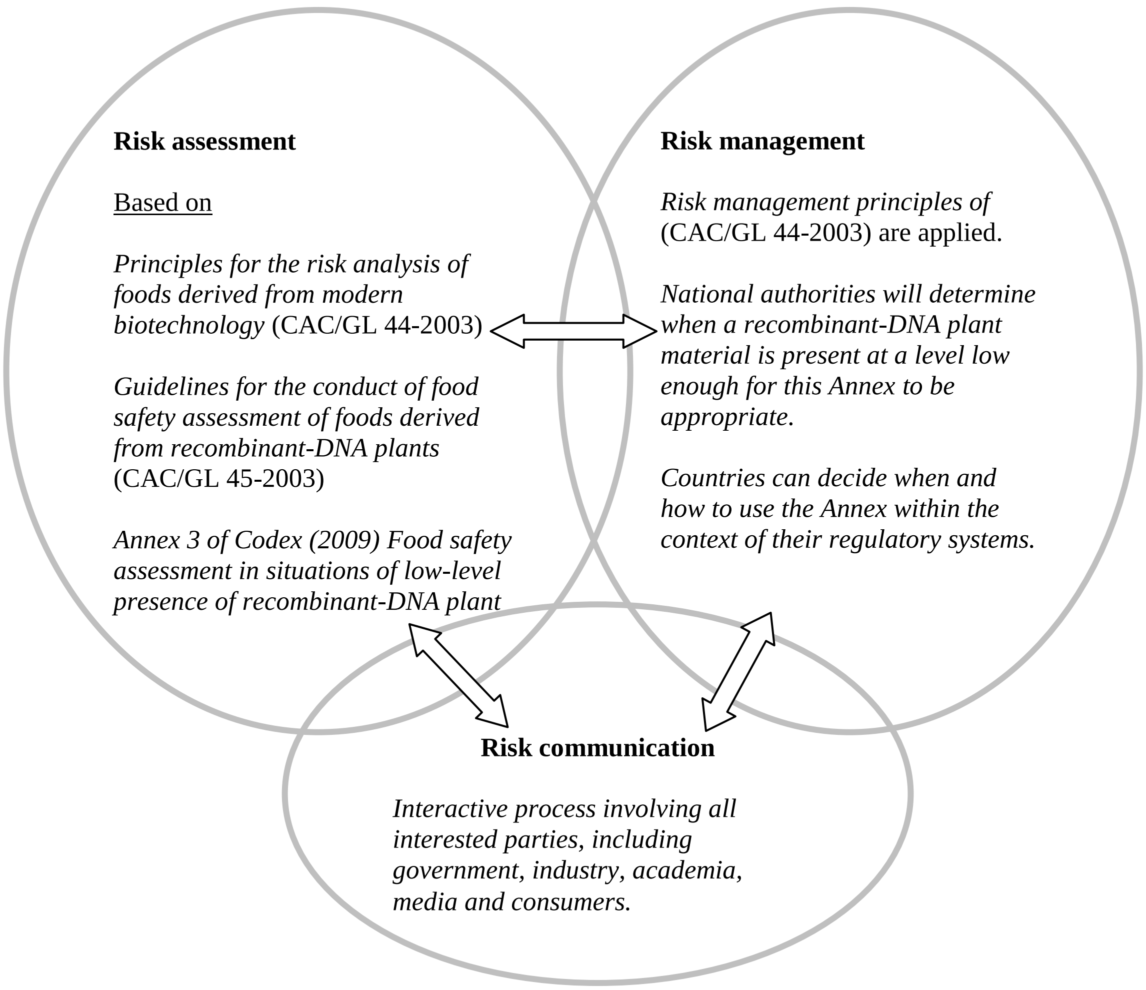
According to the Panel, these four requirements are clearly cumulative in nature and whenever one of these four requirements is not met, the measure at issue is inconsistent with Article 5.7 (WTO, 1999). The Panel found that Japan had not fulfilled the requirements contained in the second and third sentences of Article 5.7 and, therefore, the trade restriction was inconsistent with the Article 5.7 of the SPS Agreement.

In the case of *Japan's Apples* (DS 245)[25], the Appellate Body found that the measure was not a provisional measure as explained under Art. 5.7, as the measure was not imposed in respect of a situation "where relevant scientific evidence is insufficient". The Appellate Body found that the available scientific evidence in this case was enough to evaluate the likelihood of entry, establishment or spread of fire blight in Japan through apples exported from the United States (WTO, 2010d). As explained by Zarrilli (2005), the Appellate Body clarified that 'insufficiency in scientific evidence' is not similar to 'scientific uncertainty'.

According to FAO and WHO (1997), a Member's food safety measures are considered justified and in accordance with the provisions of the SPS Agreement if they are based on Codex standards and related texts. Even though the adoption and application of Codex standards remains technically non-mandatory, failure to apply Codex standards creates the potential for dispute. The Codex Alimentarius Commission (2009) introduced the guidelines for the risk analysis of foods derived from modern biotechnology. Annex Three of this guideline describes the recommended approach to the food safety assessment in situations of low-level presence of r-DNA plant material in food (ICTSD, 2008). The recommended approach is valid for the situation of asynchronous authorisation; i.e. importing country has not done any food safety assessment of the relevant GMOs but exporting country has done the food safety assessment according to the '*Guidelines for the conduct of food safety assessment of foods derived from recombinant-DNA Plants'* (CAC/GL 45-2003) of Codex (2003). As CDC Triffid flax is an authorised crop in Canada (CFIA, 2010), but not authorised in EU, this guideline is applicable for the low level presence of CDC Triffid in Canadian flaxseed shipments to EU. However, a controversy may

[25] In 2002, the US complained at WTO that Japan violates SPS Agreement by restricting imports of apples from the US due to concerns about the risk of transmission of fire blight bacterium (WTO, 2010d). In 2005, both parties reached a mutually agreed solution.

arise regarding when the food safety assessment was done for CDC Triffid. According to Health Canada the food safety assessment of CDC Triffid was done in 1999 according to its *Guidelines for the Safety Assessment of Novel Foods* (Health Canada, 1999). However, as following the Codex guidelines in risk assessment is not mandatory the EU could still do their own risk assessment. Figure 2.1 summarises the risk analysis process in situations of low-level presence of recombinant-DNA plant material in food as explained in Codex Alimentarius Commission (2009).



(Modified from Codex Alimentarius Commission, 2009)

Figure 2.1 Risk analyses in situations of low-level presence of recombinant-DNA plant material in food according to Codex guidelines

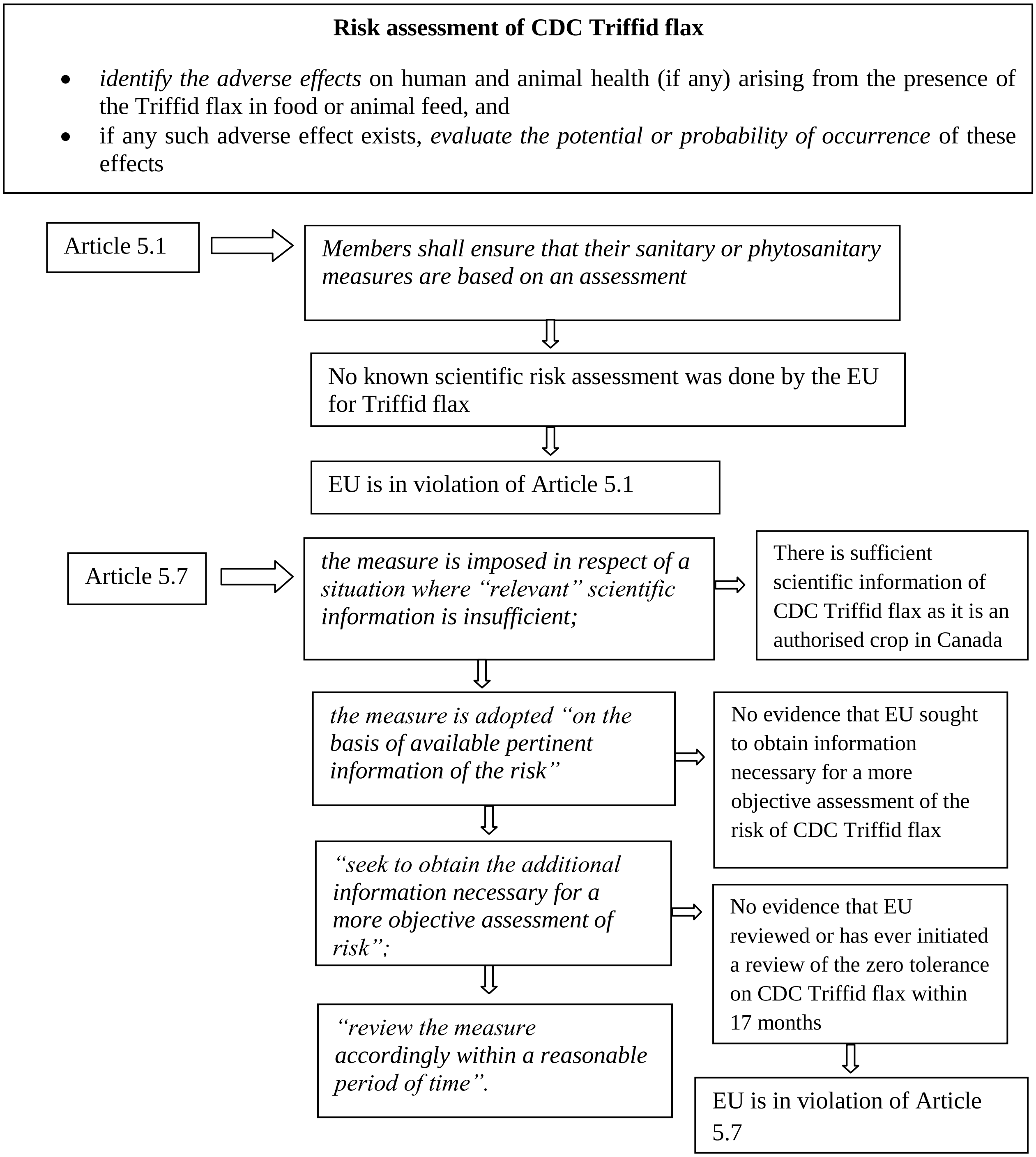
As shown in Figure 2.1, risk assessment is an integrated part of the risk analysis process. In the case of CDC Triffid flax, the risk assessment can be defined as the evaluation of the potential for adverse effects on human or animal health arising from the presence of CDC Triffid flax in food, or feedstuffs. If the EU considered the risk assessment done by Health Canada as valid scientific information they would be able to allow a threshold of 0.9 percent for the adventitious or technically unavoidable presence of CDC Triffid flax in imports of Canadian flaxseed. However, even if the EU conducted a risk assessment of their own, setting the same threshold would be the possible science based decision as CDC Triffid posed no risk to human, animal or plant health or life. (0.9 percent is the present threshold in EU for adventitious presence of approved GMOs in non-GM food to be classified as non-GM). Instead, the EU requires the zero presence of CDC Triffid in conventional flaxseed based on precaution because the EU assumes there is theoretical uncertainty in possible risk associated with CDC Triffid. However, it is a violation of SPS Agreement by the EU.

2.6.1 Violation of SPS Agreement by the EU in the case of CDC Triffid

Article 5.1 and 5.7 are related to the risk assessment and the EU is in violation of both in the case of CDC Triffid flax. Article 5.1 states: *"Members shall ensure that their sanitary or phytosanitary measures are based on an assessment, as appropriate to the circumstances, of the risks to human, animal or plant life or health, taking into account risk assessment techniques developed by the relevant international organisations"*.

The EU did not conduct any risk assessment of CDC Triffid flax based on the risk assessment techniques introduced by Codex Alimentarius Commission in 2009 in the case of low level presence of GMOs in food chain and therefore is in violation of Article 5.1 of the SPS Agreement.

Furthermore, the EU is in violation of Article 5.7 which is the precautionary principle of the SPS Agreement. According Article 5.7, an SPS measure is valid if four cumulative requirements are met. However, in the case of CDC Triffid, the EU has not met requirements one, three and four of the Article 5.7, the EU is not able to justify its zero tolerance for CDC Triffid based on 'relevant insufficiency of scientific information' because there is enough scientific information available in Canada which was used in giving approval to CDC Triffid flax. Further, SPS measure should not be maintained unless the Member seeks to "obtain the additional information necessary or a more objective assessment of risk"; and measure should be reviewed accordingly "within a reasonable period of time". Nearly 17 months passed after the EU's trade restriction on Canadian flax and there is no evidence that the EU is seeking additional information on CDC Triffd flax or conducting a risk assessment on CDC Triffid flax. Seventeen months can be considered as reasonable period of time to initiate a review of trade restriction on CDC Triffid. However, the EU has failed to meet these requirements of Article 5.7 of SPS. Figure 2.2 illustrates the EU's violation of Article 5.7 and 5.1 in the case of CDC Triffid flax. EU did not conduct any specific risk assessment of CDC Triffid flax but merely used its blanket application of zero tolerance on unapproved GMO's to restrict flax imports from Canada. In this case, the EU justifies its zero tolerance policy on scientific uncertainty related to CDC Triffid flax. However, as explained in Section 2.5, there are number of other non scientific and more influential factors behind the EU's GMO policy which support the hindering of imports of GMOs into the EU.



Source: Modified from WTO (1999)

Figure 2.2 Violation of SPS Agreement by the EU

2.7 Conclusion

Global land area under GM crops is increasing rapidly. Canada was the fifth largest GM crop growing country in 2008. In contrast, the EU has comparatively little land under GM crop cultivation. Similar to the difference in acreage under GM crops, a significant difference in regulations and perspectives can be seen when comparing GMO policy between the EU and Canada. The EU's 'zero tolerance policy' on adventitious presence of CDC Triffid flax in Canadian flaxseed exported to the EU is the latest example. The EU's zero tolerance policy is based on precaution, which is a controversial concept. According to SPS Agreement of the WTO (to which the EU is a member), the precautionary approach should be based on a scientific evidence and risk assessment. In the case of CDC Triffid flax, however, the EU did not consider the available scientific information and did not conducted any risk assessment of CDC Triffid flax, instead it merely applied its blanket application of zero tolerance. The EU did not consider the possibility of following the guidelines given in Codex Almentarius Commission in the case of CDC Triffid flax. Therefore, the EU is in violation of Article 5.1 and 5.7 of SPS Agreement. In other words, the EU has abandoned the science based regulation of trade despite its acceptance of SPS obligations. In reality, there are more influential reasons than the scientific information which led the EU to restrict the import of CDC Triffid contaminated Canadian flaxseed. However, the EU can still claim its zero tolerance policy on CDC Triffid flax is based on 'sound science' due to the inconclusive nature of the application of science in SPS Agreement. A Dispute Panel would have to be requested to resolve the issue.

Chapter 3 : Market closure of EU to Canadian flax seed

3.1 Introduction

As explained in the introductory chapter, on September 8th, 2009 the European Commission issued a Rapid Alert notification confirming the presence of CDC Triffid flax in some samples of flaxseed imports from Canada. In September 2009, the Canadian Grain Commission (CGC) also confirmed a trace amount of GM material was present in some Canadian flaxseed shipments. This led to a closure of the EU market to Canadian flaxseed.

There are currently no varieties of GM flaxseed registered in Canada. FP967, a GM flaxseed variety commonly known as CDC Triffid, received regulatory feed and environmental safety authorisations in 1996, and food safety authorisations in 1999, but was never released for commercial production (Flax Council of Canada, 2009a). According to Booker (2011), before the deregistration approximately 5000 ha of CDC Triffid was grown by Canadian seed growers across Western Canada and approximately 5500 tonnes of CDC Triffid seed were collected and crushed during the recall in 2001. According to Statistics Canada (2010d), the distribution of the positive samples in the wake of the discovery of CDC Triffid in the EU in 2009 was widespread in western Canada, making it harder to pin point a source of contamination. In April 2009, two 5000 tonne shipments of flax exported to Europe from Canada were found to be contaminated with GM flax when they arrived in port in the EU (Booker, 2011). By September 2009, the GM flax in the EU was confirmed as being the CDC Triffid variety. At a meeting of the Standing Committee on the Food Chain and Animal Health of European Commission, held in Brussels on 16 November 2009, Member States agreed that the approach to deal with CDC Triffid flax should be similar to the one followed by the Committee with respect to the control of food containing the unauthorised GM rice LL601 (EC, 2009b). Furthermore, the Standing Committee decided that illegal flaxseed should not be allowed to enter the EU market or further distributed in the food and feed supply chain. Stored bulk shipments of flaxseed imported before the Protocol had to be tested and, in case of unfavourable results, be withdrawn from the market. Member States must continue notifying unfavourable results relevant for products that may have been dispatched to other Member States. The notification should be communicated using the

RASFF (EC, 2009b). It is interesting to note that when comingling of GM rice LL601 was identified in the EU it was not an authorised crop in its originating country, the US.

3.2 Protocol developed by Canada and EU

In order to have a procedure for having Canadian flaxseed acceptable for import into the EU market a Protocol was developed by Canadian Grain Commission in consultation with the Flax Council of Canada, and DG SANCO[26] of the European Commission. Agriculture and Agri-food Canada, Foreign Affairs and International Trade Canada and the Canadian Food Inspection Agency were also involved in the development of the Protocol (CGC, 2010b). The Protocol establishes a system of sampling, testing, and documentation pertaining to the presence of CDC Triffid in the supply chain of Canadian flaxseed destined for the EU. The Protocol satisfies the EU zero tolerance policy for unauthorised GMOs. The level of detection of CDC Triffid is at 0.01percent level, i.e one GM seed in 10 000 seeds.

The Government of Canada proposed this sampling, testing and certification protocol to the European Commission and EU Member States on October 19, 2009. The European Commission advised Canada on October 29, 2009, that Member States had consented to the Commissions' approval of the Canadian protocol. However, this original protocol created unacceptable commercial risk for Canadian flax shippers and the EU officials. The reason was that the vessels started sailing prior to final test results being available. That resulted in arriving of positive cargoes in the EU. In March 2010, a revision was made to the original protocol. The revision included a "pre-load" test that allowed for final results of CGC testing to be known prior to loading the ocean vessel. Pre-load testing enables the diversion of stocks that tested positive away from the EU market. This Protocol is not considered as an official legal agreement, but is an industry commitment backed by an official CGC Letter of Analysis.

[26] DG SANCO is the French acronym for the 'Directorate-General sante' et protection des consommateurs' - Directorate-General for Health and Consumer Affairs. It is an administrative unit of European Commission and has three sections; Public Health, Food Safety and Consumer Affairs (Kirch, 2008).

Sampling

According to the revised Protocol, three samples of flaxseed must be collected as flaxseed moves through the Canadian supply chain.

> "*First, a sample will be taken by grain handling company personnel from each producer delivery into the commercial handling system. This sample will be retained for a period of no less than six months from the date of delivery. Generally, flaxseed moves from primary elevators to port position by railcar. Therefore, a second sample will be taken at the time of loading onto the railcar. Each railcar will be sampled, and composite samples representing not more than 5 railcars will be prepared. A third sample will be taken of flaxseed destined for the EU by CGC personnel at the time railcars are unloading flaxseed at the terminal (i.e. port) elevators. The CGC provides guidance on sampling methods to the Canadian grain industry in its official Sampling Systems Handbook and Approval Guide"* (CGC, 2009b).

Testing

Testing will be undertaken for the second and third samples.

> "*Grain handling companies will test composite rail car samples for the presence of FP967. If a composite sample tests positive for the presence of FP967, all railcars testing positive from which the aggregated sample was taken will be removed from the EU flaxseed supply chain. When rail cars arrive at port terminals, prior to railcar unloading, the CGC will seal all silos[27] in the elevator containing flaxseed not tested under this Protocol or that has tested positive and record the silo and seal numbers. Then the CGC will obtain a list of silos in the elevator designated for negative flaxseed destined to the EU and confirm those silos are empty prior to use. The CGC will then obtain a list of railcars that have tested negative from the grain handling companies and monitor grain flow from each railcar unload to each designated silo. Then CGC will prepare two 2.5 kilogram samples for each silo. One sample will be forwarded to an ISO 17025 accredited laboratory. The CGC will notify terminal*

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[27] Silo is a cylindrical structure used for bulk storage of grain in grain elevators.

elevator operators of the testing results for each silo. Any silo for which the composite sample tests positive will be removed from the EU flaxseed supply chain" (CGC, 2010a).

For shipments that are CDC Triffid-free, the CGC will prepare an official *Letter of Analysis* to accompany the product along with other quality certifications.

Testing Laboratories

Laboratories to conduct the above mentioned testing can only be designated as qualified if they operate and have been assessed in accordance with the ISO 17025 standard on 'General requirements for competence and testing and calibration laboratories' and if the proposed test method falls within the scope of the above assessment (CGC, 2010a). These Laboratories will employ the construct-specific method developed by a company named Genetic ID, and verified by the European Community Reference Laboratory, to detect CDC Triffid (European Commission Joint Research Center, 2009a).

Commercial segregation and quality management

The Protocol does not include any procedure to segregate positive and negative flaxseed lots. However, it assumes that all Canadian grain handling companies exporting bulk flaxseed to the EU are either ISO or HACCP certified and, therefore, they will employ internal quality management systems and practices to guard against cross contamination of flaxseed testing positively and flaxseed lots testing negatively (CGC, 2010a).

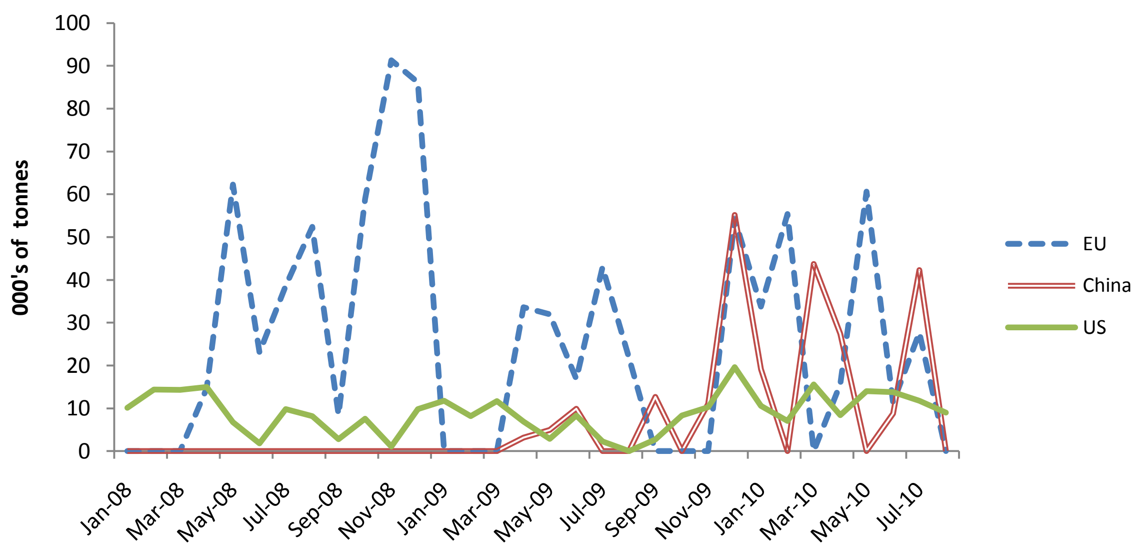
3.3 Other market closures for Canadian GM flax

Brazil has 'zero tolerance' for unapproved GM products. According to the Flax Council of Canada (2010d), as of November 4, 2009 the Government of Brazil announced the mandatory holding and testing of all flax shipments entering Brazil from Canada. If the tests prove negative, the flaxseed can enter Brazil. Several Canadian flaxseed containers have tested positive for CDC Triffid and these shipments have been halted at the border by Brazilian Ministry of Agriculture officials.

After the GM flax event in the EU, Japan's Ministry of Agriculture, Forestry and Fisheries requested that Canada's flaxseed industry implement appropriate preventive measures. Canadian Government has developed a Protocol to describe the system of sampling, testing, and documentation pertaining to the presence CDC Triffid in bulk vessel shipments of Canadian flaxseed to Japan. This protocol is specific to bulk shipments of flaxseed destined for industrial or feed use, and incorporates an allowable tolerance of one percent for CDC Triffid (CGC, 2010d). Japan imports Canadian flaxseed mainly for industrial purposes.

3.4 Changes in flaxseed exports after the CDC Triffid event

There were no exports of Canadian flaxseed to the EU in first three months after the detection of CDC Triffid flax, i.e September, October and November, 2009. However, in 2008 Canada exported 150 400 tonnes of flaxseed to EU during these three months. The decline in the export of Canadian flaxseed to EU in 2009/2010 was approximately 35 percent relative to the eight year average exports (CGC, 2000-2010, Statistics Canada, 2010f)). With the introduction of the Protocol in October, exports to the EU resumed in December 2009.



Source: Canadian Grain Commission (2000-2010)

Figure 3.1: Changes in flaxseed exports over the time

It is interesting to observe that there is sudden increase of export to China after the CDC Triffid event – see Figure 3.1. There were no exports to China in 2008; however, since November 2009 China has become a major importer of Canadian flaxseed. Exports to US increased somewhat after the CDC Triffid event. Exports to the EU on the other hand are lower than levels prior to the CDC Triffid event. Section 3.5 gives a theoretical explanation of the impact of the EU's zero tolerance policy on the flaxseed industry and linseed oil industry.

3.5 Theoretical explanation of the impact of the EU's zero tolerance policy on flaxseed industry and linseed oil industry

Figure 3.2 illustrates the changes in world flaxseed markets after the CDC Triffid event. This model is developed based on a model from Issac et al. (2002). Before the CDC Triffid event all the countries that consumed flaxseed were assumed to be CDC Triffid free. In Canada, supply is depicted by S_{Ca}. At any price above the point where S_{Ca} intersects the domestic demand curve D_{Ca}, Canada will have product surplus to domestic demand that is available for export. At any price above this domestic equilibrium price, the quantity of flaxseed available for export is the horizontal distance between S_{Ca} and D_{Ca}. The Canadian export supply of flaxseed is shown as S_{T1} in the international market.

Before the CDC Triffid event, the EU was the main importer of Canadian flaxseed. In the EU, at any price below the intersection of the domestic supply curve, S_{EU}, and the domestic demand curve, D_{EU1}, customers – largely industrial users of linseed - will be willing to purchase a greater quantity of flaxseed than domestic producers are willing to supply. Flaxseed imports from Canada are used to make up this shortfall. China was a minor importer of Canadian flaxseed before the CDC Triffid event. Similar to the EU, in China, at any price below the intersection of the domestic supply curve, S_{CH}, and the domestic demand curve, D_{CH1}, customers will be willing to purchase a greater quantity of flaxseed than domestic producers are willing to supply. For simplicity, other importers of Canadian flaxseed are not considered here. Therefore, flaxseed imports of the EU and China at different prices are depicted by the import demand function, D_{T1}, in the international market. Prior to the discovery of CDC Triffid flax in the EU, the quantity traded was the determined by the equilibrium price P_{w1} in the international market. At P_{W1}, Canada exported Q_B- Q_A of flaxseed and the EU imported Q_D- Q_C and China imported quantity Q_F-Q_E. Total import demand at P_{W1} in the international market was Q_1.

When CDC Triffid flax was discovered, the effective demand for Canadian flaxseed in the EU decreased from D_{EU1} to D_{EU2} due to high regulatory costs. The decreased demand in the EU leads to decreased price and decreased demand of flaxseed in the international market. Due to this low price, the Chinese quantity demanded of Canadian flaxseed increased and eventually, the international market demand for Canadian flaxseed declined to D_{T2}. At international market demand D_{T2}, equilibrium price became P_{W2}[28]. At the price of P_{W2}, Chinese imports of Canadian flax became Q_J – Q_I. At P_{W2} Canadian exports decreased to Q_H – Q_G. Amount of flaxseed traded at international market decreased to Q_2 (See Figure 3.2).

[28] After the CDC Triffid incident, Chinese and the EU markets for Canadian flaxseed became two heterogeneous markets. The international market demand (D_{T2}) in Figure 3.2, represents the short run flaxseed demand of China.

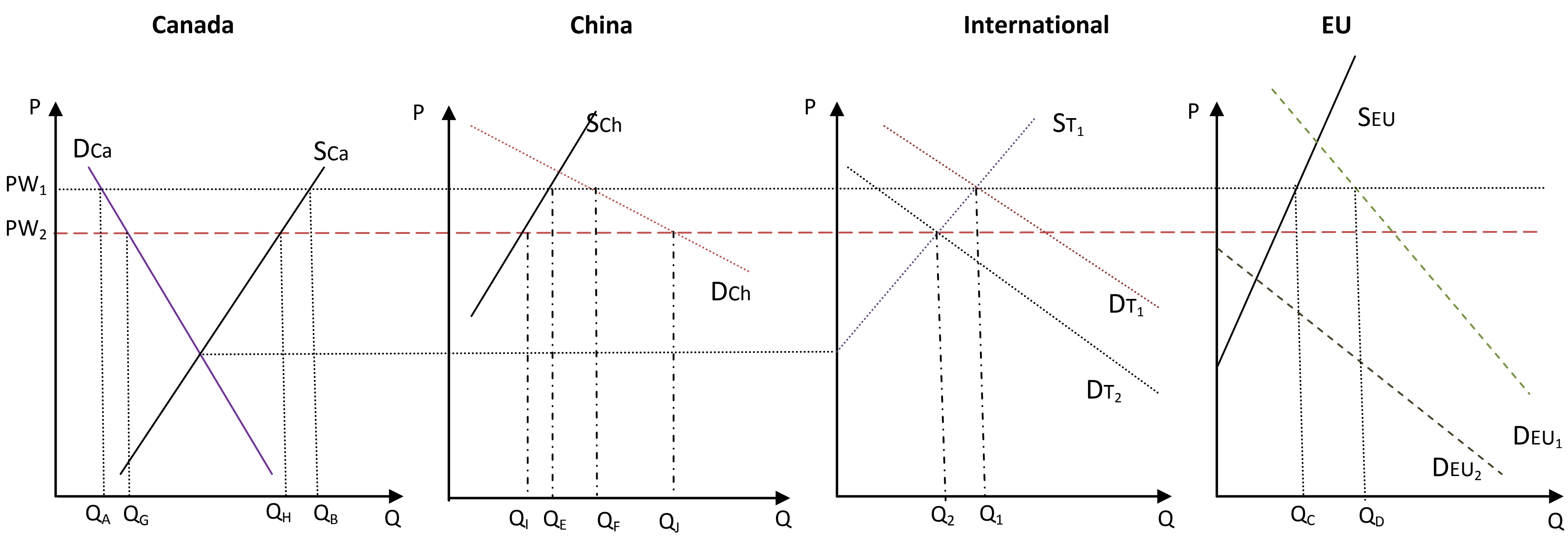


Figure 3.2: Changes in flaxseed market after the Triffid event

According to UNcomtrade (2010) linseed oil export from China doubled in 2009 compared to average linseed oil exports of previous five years. In addition, linseed oil export of US increased by 10 percent in 2009 compared to the previous four year average exports. Figure 3.3 illustrates the changes in linseed oil market after the CDC Triffid event. Before the CDC Triffid event the supply of linseed oil in the international market (S_{T1}) was dominated by flaxseed oil exported from the EU. The contribution of the US and China was marginal and S_{T2} represent the total supply of linseed oil from the EU, the US and China. In the EU, supply is depicted by S_{EU1}. At any price above the point where S_{EU1} intersects the domestic demand curve D_{EU}, the EU will have product surplus to domestic demand that is available for export. At any price above this domestic equilibrium price, the quantity of linseed oil available for export is the horizontal distance between S_{EU1} and D_{EU}. Similarly, linseed oil available for export in China is the horizontal distance between S_{CH} and D_{CH} and linseed oil available for export in US is the horizontal distance between S_{US} and $D_{US.}$ The equilibrium amount of linseed oil traded at international market was Q_1 and equilibrium price was P_{W1} (See Figure 3.3).

Once Canadian flaxseed imports to the EU decreased due to the CDC Triffid event, the linseed oil supply of the EU decreased to $S_{EU2.}$ The decrease in the EU linseed oil exports was Q_A-$Q_{B.}$ The EU's supply of linseed oil to international market declined from S_{T1} to S_{T3}. Due to reduction in supply the price of linseed oil in the international market increased. Due to high price China increased its supply of linseed oil by quantity Q_D-Q_C and US increased its supply by quantity Q_F-Q_E . This leads to an increase of linseed supply for the international market of S_{T4}. At the supply of S_{T4} equilibrium price of international market became P_{W2}.

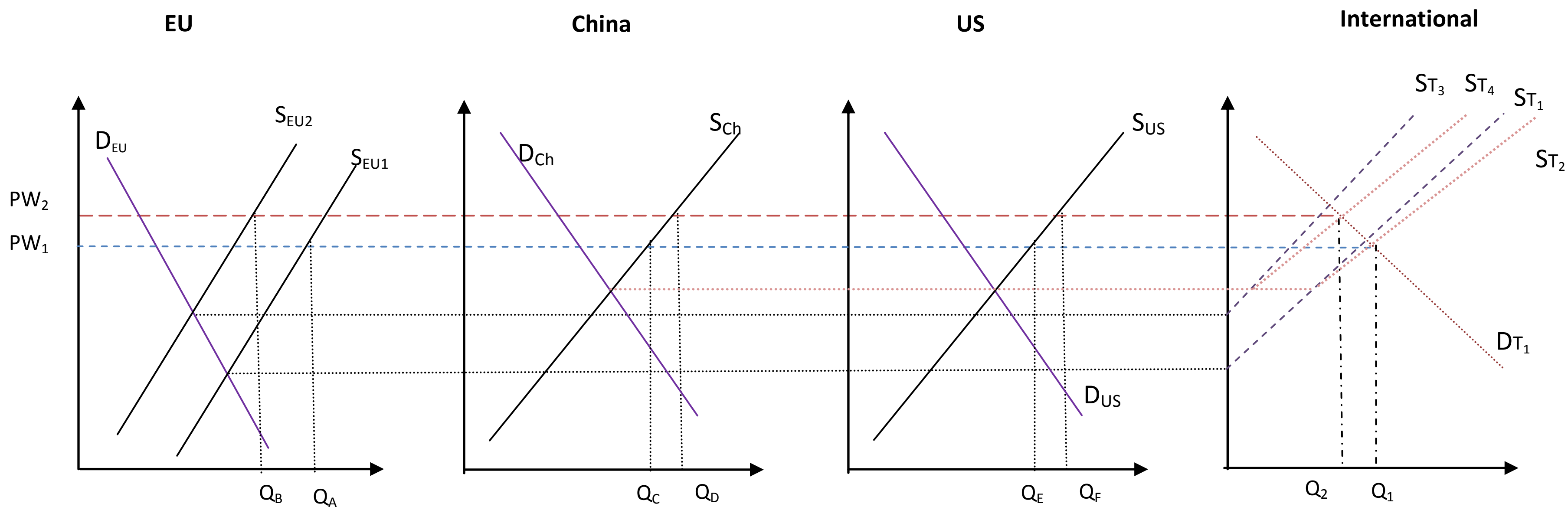


Figure 3.3: Changes in linseed oil market after the Triffid event

Due to the CDC Triffid event market share of EU in the world linseed oil market decreased while the market share of US and China increased. It is also interesting to note that both the US and China use GM comingled flaxseed of Canada to produce linseed oil while the EU use GM free flaxseed to produce linseed oil. As GM free flaxseed comes to the EU with a risk premium, the cost of production of linseed oil in the EU is higher than it is in the US and China. Therefore, other than the decreased market share, the EU has lost its competitiveness in the linseed oil market due to the CDC Triffid event.

3.6 Conclusion

With the detection of CDC Triffid flax in the EU, flaxseed exports from Canada to the EU declined drastically. In order to have a procedure for having Canadian flaxseed acceptable for import into the EU market a Protocol was developed. After the introduction of the Protocol, flaxseed exports to the EU increased gradually but did not return to the level prior to the CDC Triffid incident. In contrast flaxseed export from Canada to China increased significantly after the CDC Triffid incident. The reduced flaxseed imports of the EU from Canada resulted in lower linseed oil exports from EU. However, the supply of linseed oil from China and the US increased because they were able to import more flaxseed from Canada at the lower price. The international markets for flaxseed and linseed oil are, however, still adjusting to the CDC Triffid incident market shocks. In what follows, the short run costs associated with the CDC Triffid event are investigated. A model of the flaxseed supply chain is first developed and then the short run costs associated with the CDC Triffid event are attributed to the various actors along the supply chain.

Chapter 4 : Overview of Flaxseed Industry

4.1 Introduction

Flax is an ancient crop. Wall paintings depicting flax cultivation, and cloth made of flax fibre were found in some of the oldest burial chambers of the Egyptians, dating from around 3000 B.C (Erasmus, 1986). For centuries, people around the world have been using the flax plant for food, animal feed, medicine and fibre. The history of flax in Canada dates back almost 400 years to 1617 when Louis Hébert, thought to be the first farmer in Canada, cultivated flax in 'New France'. By 1875, European settlers were seeding the newly broken western prairie with flax brought from their homelands (Flax Council of Canada, 2009b). Flax flourished in the rich soils of the prairies and by the 1990's the Canadian provinces of Alberta, Manitoba and Saskatchewan collectively became the world leader in flaxseed production.

4.2 Uses of flaxseed

Industrial applications

The main use of Canadian produced flaxseed is for the production of linseed oil. Linseed oil is an input into a number of industrial products including: linoleum, oilcloths, paints, resins, inks, varnishes and other coatings (Berglund, 2002). Linoleum is a flooring that is manufactured by oxidising linseed oil to form a thick mixture called linoleum cement. The cement is cooled and mixed with pine resin, and wood flour[29] to form sheets on a jute backing. Linoleum contains approximately 30 percent linseed oil (Flax Council of Canada, 2010c). The drying quality of flaxseed oil[30] is useful for these industrial applications (Rowland et al, 1995). One of the main demands for Canadian flaxseed is for manufacturing linoleum.

[29] Wood flour is made out of ground-up timber.

[30] The drying quality of flaxseed oil is due to alpha linolenic acid which contains 3 double bonds that are easily oxidised and with enough heat polymerise to form a translucent film (Marian and Morris, 2003).

Nutritional qualities of flax used for human consumption

Flaxseeds contain 45 percent oil, 22 percent protein, 12 percent fibre, 10 percent mucilage[31], 4 percent minerals and 7 percent water (Erasmus, 1986). The uniqueness of flax seed oil is due to its richness in essential fatty acids. Flax seed oil contains 57 percent of the *omega-3 fatty acid*, unsaturated alpha-linolenic acid (ALA) which is said to be helpful in reducing the risk of cardiovascular diseases and cancers (Morris, 2003). Flax seed also contains soluble and insoluble *fibre*. Soluble fibre helps lower blood cholesterol levels, while insoluble fibre assists in bowel movements. *Lignans* in flax are said to be helpful in protecting against certain kinds of cancer, particularly cancers of the breast and colon, by blocking tumour formation (Morris, 2003). As a result of these findings of health-promoting or disease-prevention properties of flax seed, it is becoming a popular functional food[32].

As explained by Jalla (2010), the direct use of unprocessed conventional flax oil in the human diet is limited by product stability. Linseed oil with high ALA is highly susceptible to oxidation[33]. Therefore, flax is mainly used in milled or whole seed form in food recipes. There is a new flaxseed variety named Solin, which contains less than 5 percent linolenic acid compare to conventional flaxseed. Soiln is used to produce polyunsaturated edible oil similar to sunflower oil. It has yellow seeds whereas other verities of flax have brown seeds (Flax Council of Canada, 2010d).

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[31] Mucilage in flaxseed is a type of polysaccharide that becomes viscous when mixed with water or other fluids (Morris, 2003).

[32] A functional food is similar in appearance to, or may be, a conventional food, is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions (Health Canada, 2002**).**

[33] Oxidisation leads to rancid flaxseed oil with an unpleasant odor with in few weeks. In general, rancid oils are considered as being carcinogenic.

Cosmetic products

Flax seed mucilage is used for the treatment of skin inflammation. Its strong hydrating properties are used for skin moisturising purposes. Flaxseed oil is a popular ingredient of specialty soaps, lotions, shampoos and other cosmetic products (Koslowska et al., 2008).

Nutritional animal feed

The industrial process which produces linseed oil yields the by-product linseed meal. It is considered a premium protein feed, especially for ruminants. It is utilised in some dairy cow rations and can be a component of beef cow, calf, hog, sheep, goat and horse diets. As explained by Erasmus (1986), flax has been used since antiquity to maintain good health in animals including; correction of digestive disturbances (e.g. bloating in calves), to produce glossy coats, to correct respiratory infections, etc. Moreover, poultry, beef, pork, milk, milk products and eggs can all have enhanced omega-3 fatty acid levels through the addition of flax in any of its various forms to the diet of the source animal (SaskFlax, 2009a). As explained by Koslowska et al. (2008), adding flaxseed oil to poultry feed enriches omega-3 polyunsaturated fatty acid levels in eggs.

4.3 Uses of flax fibre

To date in Canadian flax industry, there is no significant commercial role for flax fibre. Farmers who grow flax for seed leave much of straw in the field to be burnt. However, as explained by Ulrich and Richards (2007) there is a potential market for fibre as well. According to Berglund (2002), in Europe there is considerable interest in the use of natural fibre in interior panels, visors, and other parts of automobiles and General Motors has Canadian flax fibre in the rear parcel shelf of selected models.

The major fibre flax cultivating country in the world is China with 110000 ha in 2007. China imports 80 percent of long flax fibre produced in France and Belgium which is used to produce high quality linen fabric. Other major fibre flax cultivating countries are Russia, France, Belarus, Ukraine, Belgium and the Netherlands (Mackiewics-Talarcsyk et al, 2008). Long line fibre is used in manufacturing high value linen products, while short staple fibre[34] has been the waste from long line fibre and used for lower value products like blankets, mats, mattresses and carpets (Jalla, 2010).

4.4 Flaxseed production of Canada

Flax has been an important export crop for Canada. In the 2008/09 crop year Western Canada produced 861 000 MT of flaxseed (Statistics Canada, 2010b).

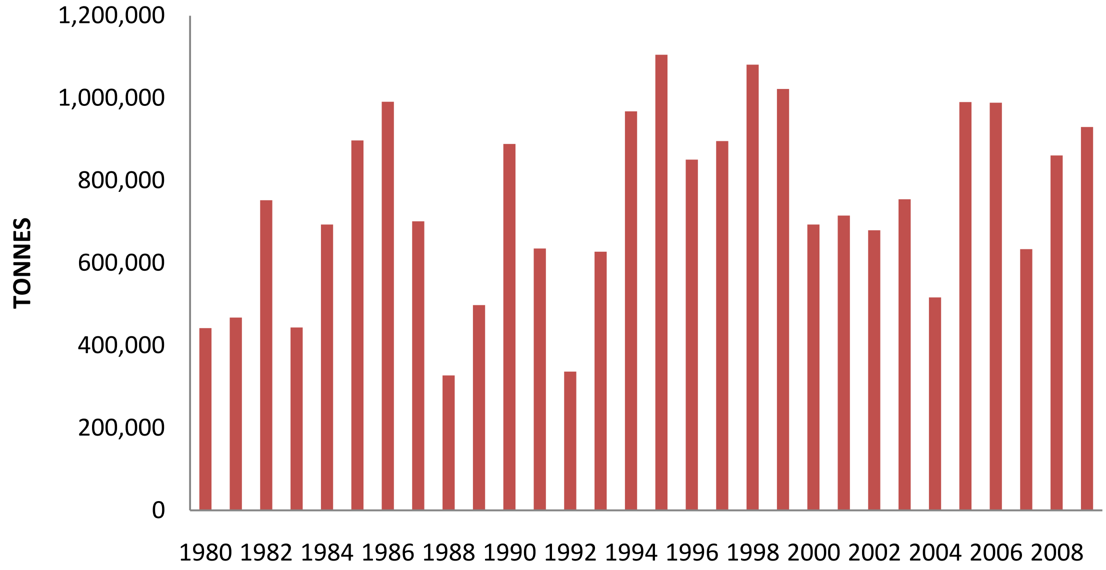
Table 4.1: Comparison of flax and other main crops grown in Canada

Crop	**Average 2003/04 to 2007/08**			
	Area harvested (000's ha)	**Yield (kg/ha)**	**Production (000's MT)**	**Export (000's MT)**
All wheat (including Durum)	8 971	2 420	21 570	16 019
Barley	3 719	3 140	11 391	2 695
Oats	1 455	2 580	3 735	2 042
Corn	1 163	8 320	9 636	406
Canola	5 260	1 600	8 506	4 743
Dry peas	1 353	2 240	3 023	2 283
Soybean	1 152	2 540	2 855	1 358
Flax	658	1 180	777	596
Lentils	625	1 250	798	630

Source: Statistics Canada (2010b)

Flax has become a popular crop in the normal cropping rotation of many farms in the prairies. The major oil seeds grown in Canada other than flax are canola, soybean and sunflower seeds. Figure 4.1 shows changes in flax seed production in Canada from 1980 to 2009.

[34] When flax fibre cut into 2.5 inch lengths or less then it is called short staple fibre (USDA, 2005).



Source: Statistics Canada (2010c)

Figure 4.1: Flaxseed production of Canada from 1980 to 2009

The highest production was in 1995 with 1.10 million tonnes while the lowest production was in 1988 with 0.32 million tonnes. Saskatchewan is the single largest producer of flaxseed in Canada and in the 2008/2009 crop year the province produced 77 percent of the total Canadian flax crop. Manitoba is the second largest flax growing province while Alberta ranks third, see Table 4.2. According to the Canadian Grain Commission (2009a), New Brunswick, Nova Scotia and Prince Edward Island also contribute to flaxseed production.

Table 4.2: Production of flax seed by province (‘000 tonnes)

Year	Manitoba	Saskatchewan	Alberta	Western Canada Total
2000	205.7	469.9	17.8	693.4
2001	199.4	495.3	20.3	715.0
2002	214.6	444.5	20.3	697.4
2003	195.6	533.4	25.4	754.4
2004	132.1	355.6	29.2	516.9
2005	147.3	881.4	53.3	1,082.0
2006	193.0	759.5	36.3	988.8
2007	105.4	511.8	16.3	633.5
2008	161.3	666.8	33.0	861.1
2009	193.0	708.7	28.4	930.1
2010	81.3	454.7	34.3	570.3

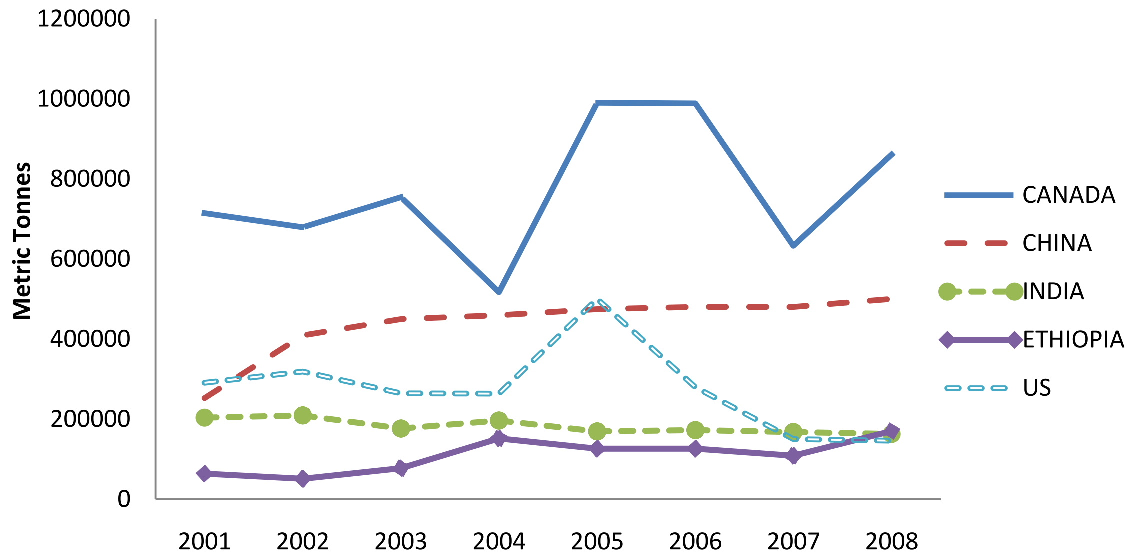
Source: Flax Council of Canada (2010e)

Total flaxseed production in western Canada decreased by 38 percent from 2009 to 2010. According to the Saskatchewan Ministry of Agriculture (2010), flaxseed seeded area in Saskatchewan decreased by 25 percent from 2009 to 2010. The main reason for the decrease in seeded area and production may be the disrupted flaxseed market in the EU. Heavy rains and excess wet conditions during the 2010 growing season may also have had some effect on reducing seeded area and production[35].

4.5 World Flaxseed production

Global flaxseed production was 2 410 000 metric tonnes in 2009/2010 (Statistics Canada, 2010f). Canada represents about 40 percent of world flaxseed production while China, the US, Ethiopia and India, together account for 40 percent of world production. Figure 4.2 illustrates the changes in flaxseed production over time.

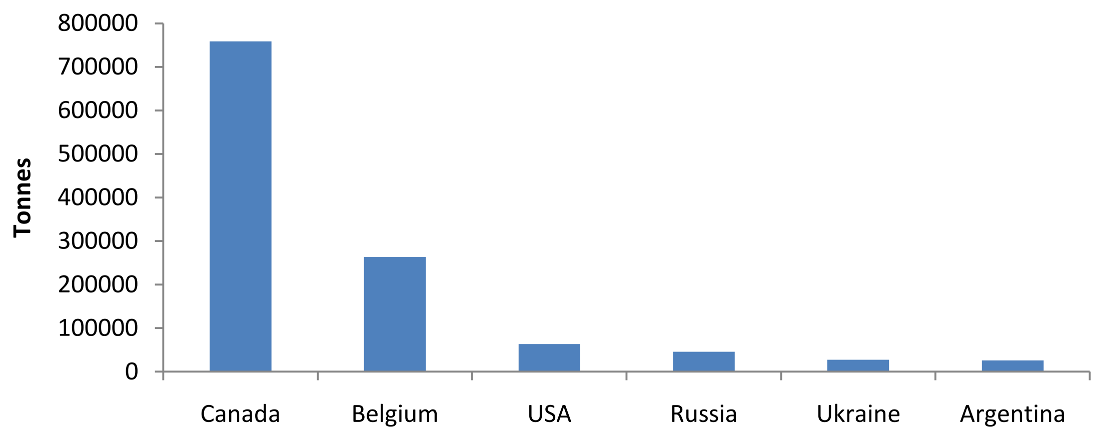
[35] According to Statistics Canada (2010h) producers in Saskatchewan, Manitoba and Alberta managed to plant only 76 percent, 95 percent and 95 percent of the intended acres respectively in 2010 due to excess moisture conditions.



Source: FAO (2009)

Figure 4.2: **Major flaxseed producing countries**

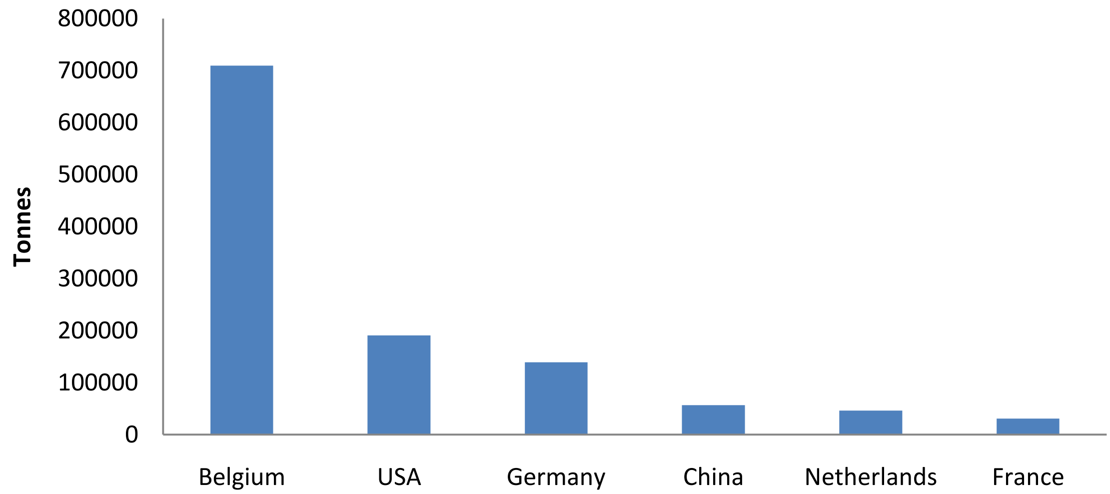
The production of the US and India has a declining trend while Ethiopia and China exhibit an increasing trend. Even with considerable fluctuations, Canada has maintained its position as the global leader in flaxseed production throughout the first decade of the 21st century. Canada is the largest exporter of flaxseed as well. Figure 4.3 shows the major flaxseed exporting countries in 2008 and Figure 4.4 shows the major importing countries for 2007.



Source: FAO (2009)

Figure 4.3: **Major flaxseed exporting countries, 2008**

Some of the major producers use their production mainly for domestic consumption while countries like Belgium export much of what they import from other countries, mainly from Canada. Figure 4.4 shows that Belgium is the main importer of flaxseed in 2007 while Figure 4.3 shows Belgium as the second largest exporter.



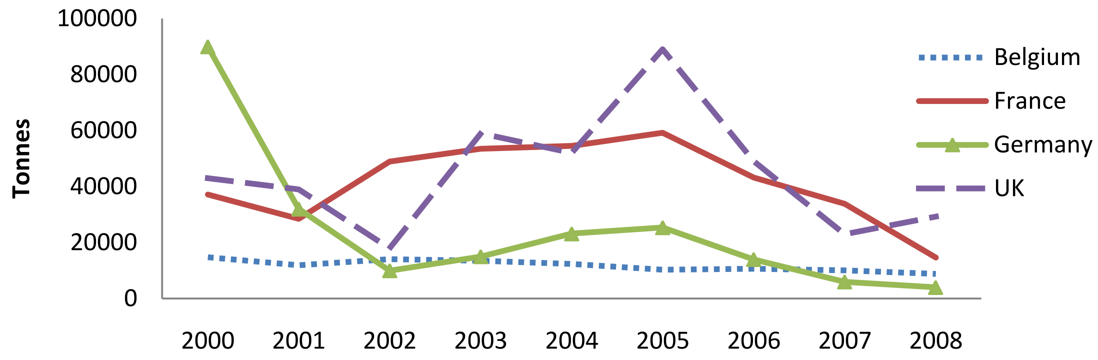
Source: FAO (2009)

Figure 4.4: **Major flaxseed importing countries, 2007**

This largely reflects transhipment as Antwerp in Belgium is the major port of import for Western Europe. The main flaxseed oil crushing plants in the EU are located in Belgium and Germany.

4.6 Flaxseed production in the European Union

Within the EU, the main producers of flaxseed are the United Kingdom, France, Belgium and Germany (FAO, 2009). Figure 4.5 shows the changes in the flax seed production of those countries over time. In the EU, the volume of flaxseed processed by the operators for all uses is approximately around 500 000 to 600 000 tons per year. Around 80 percent of that is imported from Canada and the remaining volumes come either from Russia, Ukraine, the US or from EU production (COCERAL and FEDIOL, 2010).



Source: FAO (2009)

Figure 4.5: Flaxseed production in the EU

Figure 4.5 shows a sharp decline in flaxseed production in the EU. For example, German production in 2008 is approximately 40 percent of the production in 2000. As explained by Agriculture and Agri-food Canada (2007b), the EU has an expanding biofuel industry and biodiesel requires rapeseed as an input, not flaxseed. The relative price of rapeseed has risen, leading to a large switching out of flaxseed production in the EU. It has been predicted that flaxseed production in the EU will continue to decline and, as a result, import demand will be strong in future.

4.7 Canadian export markets for flaxseed

The EU has historically been the largest importer of Canadian flaxseed, most of which is crushed in Belgium and Germany to produce linseed oil. Only a small amount (less than 20 percent,) is sold to the food industry for human consumption. Canada exports flaxseed primarily in the form of unprocessed raw seeds. In the 2008/2009 crop year, Canada exported 639 000 tonnes of flaxseed. If average export volumes from 2003/2004 to 2007/2008 are considered, major export destinations were Belgium[36] (65%), the US (23%), China (4%) and Japan (2%) (Statistics

[36] These figures may be somewhat misleading as one of the major ports of import of all of northern Europe is Antwerp in Belgium. Thus, while flaxseed may enter Europe through Antwerp, it may not actually be destined for Belgium.

Canada, 2010b). In the Statistics Canada and Canadian Grain Commission data bases exports to Europe is divided as exports Western Europe and exports to Eastern Europe. In the case of flaxseed export, countries mention under Western Europe belongs to European Union. Therefore, flaxseed exports to Western Europe can be considered as exports to the EU. Table 4.3 shows the total exports of flaxseed in recent years.

Table 4.3: Export of flaxseed by country of final destination (000's MT)

Country	**Average 2003/04 to 2007/08**	**Total 2007/08**	**Total 2008/09^r**	**August to March 2008/09^r**	**August to March 2009/10^p**
Belgium	395	413	416	291	152
Germany	1.4	6.1	1.4	0.7	1.1
Netherlands	0.6	1.5	0.8	0.3	0.5
Spain	0.9	0.3	0.2	0.2	0.3
Western Europe total	**399.6**	**425**	**429.9**	**302.7**	**157**
Eastern Europe total	**0.4**	**1.1**	**0.8**	**0.4**	**0.2**
Egypt	5.9	0	0.7	0.2	4.1
Middle East total	**6.6**	**1.3**	**2.5**	**1.1**	**9.8**
Morocco	0.3	0.4	0.5	0	0.2
Africa total	**0.9**	**1.7**	**1.7**	**0.8**	**0.9**
China	24.9	46.9	70.6	15.2	161.8
Japan	16.1	10.6	7.9	5.4	29.6
South Korea	0.2	0.4	0.4	0.3	0.3
Asia total	**41.5**	**58.4**	**79.8**	**21.3**	**192.7**
Oceania Total	**1**	**2.9**	**1.1**	**1.1**	**0.1**
Colombia	1	1.5	1.9	1	0.4
South America total	**2.9**	**5.3**	**5**	**2.3**	**7.4**
Mexico	2.8	4.2	4.6	2.6	2.8
Central America and Antilles total	**3.5**	**5.5**	**5.9**	**3.4**	**3.6**
US	139.3	182.5	111.7	84.1	115.3
Total Exports	**595.7**	**683.7**	**638.5**	**417.2**	**487**

^{r} revised, ^{p} preliminary

Source: Statistics Canada (2010b)

It is important to note that as exports to the EU have decreased, export to Asia, especially to China, increased dramatically from 2008 to 2009 as Canadian flax was forced to seek alternative markets. In 2009/2010, the EU only accepted 35 percent of total Canadian flaxseed exports. However, if 2000 to 2008 exports are examined, the EU accounted for 73 percent of Canadian flaxseed exports. See Table 4.4.

Table 4.4: The share of the EU in Canadian flaxseed export markets (000's MT)

Year	Total production	Total exports	Exports to EU	% of exports from total production	% of exports to EU from total exports
2000	693.4	582	471	81	84
2001	715	581	504	87	81
2002	697.4	531	468	88	76
2003	754.4	562	462	82	74
2004	516.9	415	315	76	80
2005	1,082.00	440	355	81	41
2006	988.8	579	466	80	59
2007	633.5	545	415	76	86
2008	861.1	638	430	67	74
Average	771	552	421	80	73

Source: CGC (2000- 2010)

It is apparent that the export market is vital for Canadian flaxseed industry as 80 percent of the production is destined for export. Similarly, the EU is the main market for Canadian flaxseed as it accounts for most of the exports.

Canada also exports flaxseed oil and flaxseed meal. See Table 4.5. From 2003/2004 to 2007/2008 the main flaxseed oil importers were Japan (48%), the US (30%) and South Korea (13%) while the main flaxseed meal importer was the US (95%).

Table 4.5: Export of Linseed oil and meal by country of final destination (Tonnes)

Country	Average 2003/04 to 2007/08	Total 2007/08	Total 2008/09[r]	August to July 2008/09[r]	August to July 2009/10[p]
Linseed oil					
Japan	5116	2088	2453	2453	558
US	3192	3141	1746	1746	837
Korea, south	1407	1902	734	734	5
United Kingdom	350	193	105	105	44
China	239	2451	2574	2574	2679
Other countries	398	1635	247	247	54
Total Exports	10702	11410	7859	7859	4177
Linseed meal					
US	16684	8713	6108	6108	3353
Belgium	820	4100	0	0	0
Other countries	154	5	94	94	126
Total Exports	17658	12818	6202	6202	3479

(Source: Statistics Canada, 2010b)

The linseed oil and meal exports have decreased around 50 percent in 2009/2010 compare to 2008/2009. However, linseed oil exports to China increased slightly over that period of time.

4.8 GM flax

Rapid increase of global acreage of GM crops between 1996 and 2008 indicates that it has been the most rapidly adopted crop technology in recent history (James, 2008). According to Brooks and Barfoot (2010), herbicide tolerant crops account for 65 percent, and insect resistant crops account for 35 percent of global plantings of GM crops. Stacked traits are also increasingly important feature of biotechnology crops, which means more than one trait is in one GM crop.

For example one stacked maize variety in the US was a triple stacks conferring resistance to two insect pests as well as being herbicide tolerant.

CDC Triffid is a herbicide tolerant GM flax variety developed by the Crop Development Centre of the University of Saskatchewan in 1994. CDC Triffid flax is tolerant to soil residues of herbicides such as triasulfuron and metsulfuron-methyl. These herbicides were used in western Canada to control broadleaf weeds in wheat and barley. Commercial formulations were Glean^{TM}, Ally^{TM}, and Refine^{TM} which were produced by DuPont (McHughen, 2000). Residues of these sulfonylurea herbicides persisted in soil for several years after their use. Crop rotation was limited during this period of time as commercially unacceptable injury to many crops may occur including damage to flax. Only crops such as wheat, oats and barley can be grown in these soils in the season following application of these herbicides or the land must be summer-fallowed (CIFA, 1996).

As explained by the CFIA (1996),

> "*The development of CDC Triffid was based on recombinant DNA technology and Agrobacterium-mediated transformation. An altered acetolactate synthase ensyme (ALS) from Arabidopsis thaliana was integrated into the genomic DNA of flax to confer tolerance to chlorosulfuron. Two other genes were also inserted: one conferring resistance to kanamycin, the other coding for the ensyme nopaline synthase. Both of these traits were used to select successful transformants in vitro".*

In 1996 the CFIA, authorised CDC Triffid for unconfined release into the environment and for use as livestock feed (CFIA, 1996). Health Canada conducted a comprehensive assessment of CDC Triffid according to its *Guidelines for the Safety Assessment of Novel Foods-1994,* and concluded that CDC Triffid flax does not raise concerns related to human food safety (Health Canada, 1994 and 1999).

However, as explained in Chapter 1, CDC Triffid was deregistered by the CFIA in 2001**,** due to the fear of losing the main market for Canadian flax after the EU placed a moratorium on the import of GM crops. In 2009, adventitious presence of CDC Triffid was identified and the testing results have indicated that almost all positive results have been below the 0.1 percent level (Hall, 2010). This is a low level presence, representing 1 seed in 1000 seeds.

4.9 Conclusion

Flax has been an important export crop for Canada. Saskatchewan is the single largest producer of flax seed in Canada and in the world. China is the second largest producer of flaxseed. The main use of Canadian produced flaxseed is for the production of linseed oil. The export market is vital for Canadian flaxseed as 80 percent of the production is exported. From 2000 to 2008, the EU accounted for 73 percent of Canadian flaxseed exports. However, in 2009/2010, the EU only provided a market for 35 percent of the total flaxseed exports of Canada. The main reason for this large decrease in imports by the EU was stemming from the presence of CDC Triffid in Canadian flaxseed exports. CDC Triffid was authorised for feed and environmental release and for human consumption in Canada. However, it was deregistered in 2001 by the CFIA. Through deregistration, the flaxseed industry of Canada attempted to escape from the negative impacts of the EU's moratorium on GMO imports. However, adventitious presence of CDC Triffid resulted in a considerable additional cost and changes in revenue to the industry in 2009/2010. The next chapter focuses on estimating those additional costs and changes in revenue associated with the CDC Triffid event.

Chapter 5 : Estimating Total Additional Cost and Changes in Revenue Associated with Adventitious Presence of GM Flax in Flaxseed Supply Chain

5.1 Introduction

Prior to identifying GM flax in the supply chain, the main importer of Canadian flaxseed was the European Union. After the incident, exports to EU were reduced significantly. To keep this important market accessible to Canadian flax, the actors along the Canadian flax supply chain are expected to follow the Protocol related to flax importation developed by Canada and the EU. As the EU has ‘zero tolerance’ for unauthorised GMO’s, the Protocol requires a number of tests to detect the possible presence of GM flax along the supply chain. Further, the potential for the comingling of GM and non GM flax along the supply chain is a fundamental concern of the Protocol. Therefore, understanding the flaxseed supply chain is essential to undertaking estimates of the economic impacts associated with the adventitious presence of GM flax in the flaxseed supply chain.

5.2 The flaxseed supply chain

The flaxseed supply chain includes all activities occurring between the production of flaxseed and its final use by consumers. Here commercial production of flaxseed on farms for commercial use is considered as the production. In addition, the flaxseed production of plant breeders and commercial seed multipliers is also included in the supply chain as planting seed played an important role in CDC Triffid flax incident. As the production of flaxseed is a comparatively small industry in Canada, there is little published information pertaining to the supply chain. This chapter, however, develops stylised picture, or model, of the flaxseed supply chain based on the available information. The model is used as a basis for estimating the costs associated with the adventitious presence of CDC Triffid.

Figure 5.1 illustrates the conventional flaxseed supply chain. Flaxseed plant breeders, commercial seed multipliers, flaxseed producers, grain handling companies and consumers are the main actors in the supply chain. In addition, the Flax Council of Canada, the Canadian Grain Commission, Agriculture and Agri-food Canada and the Saskatchewan Flax Development Council also play major role in the industry. As a result of the CDC Triffid event, the cost borne by all of these stakeholders has increased. The main additional costs are associated with testing for GM flaxseed and the segregation of GM comingled flaxseed and GM free flaxseed. Therefore, to estimate the total cost associated with the EU's closing of the market for Canadian flax due to CDC Triffid contamination, the costs borne by each of the stakeholder categories has to be evaluated separately. Figure 5.2 illustrates the new model for supply chain after implementation of sampling and testing for GM flaxseed and segregation of GM comingled and GM free flaxseed.

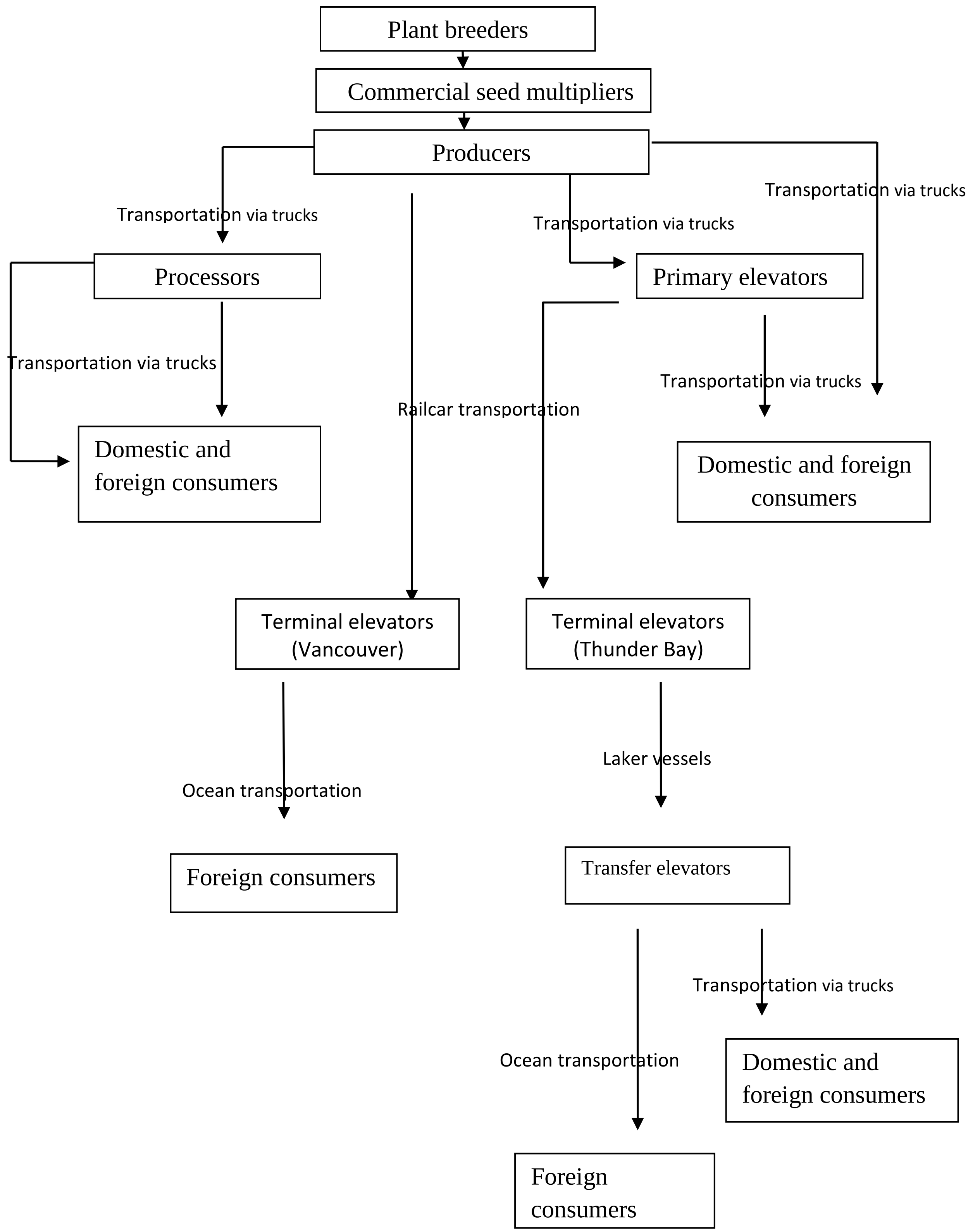


Figure 5.1: Conventional Flaxseed Supply Chain

This CDC Triffid event has created two scenarios for the supply channel for flaxseed. Firstly, there are flaxseed lots that have failed the test for being CDC Triffid free. Secondly, there are seed lots that pass the test and are CDC Triffid free. Based on the results of the tests, the direction of the seed flow may change. Seed lots with positive results may divert from the traditional seed flow to the EU, instead going to markets not sensitive to GM flax; for example, China, the US or the domestic market. The primary market for CDC Triffid free flax is the EU. Figure 5.2 illustrates the main changes in the flaxseed supply chain after the CDC Triffid event. Other than the EU, CDC Triffid free flax will go to Japan and Brazil as well.

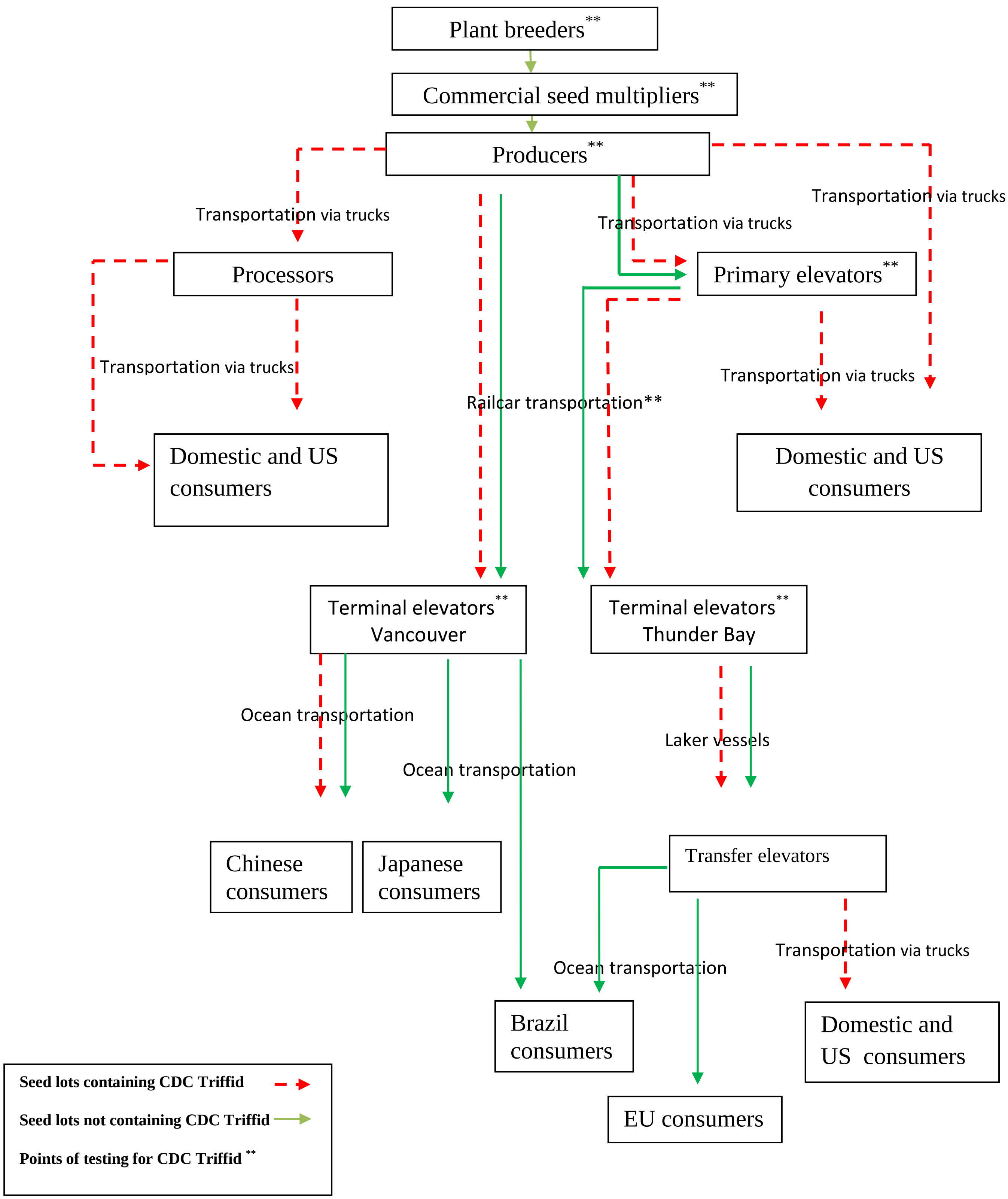


Figure 5.2: Model for flaxseed supply chain after the CDC Triffid issue

As shown in Figure 5.2, the flaxseed supply chain has become more complicated since the GM event. There are additional costs of handling GM free and GM comingled flaxseed. The important additional costs are the cost of testing (CTe) and cost of segregation (CSe) along the supply chain. However, there are number of other costs (COt) that can be incurred along the supply chain due to the CDC Triffid event. By summing up these additional costs, Total Additional Cost (TAC_{Canada}) can be estimated. In addition, due to lower prices and changes in exports volumes there are changes in revenue derived from flaxseed exports after the CDC Triffid event.

$$\mathbf{TAC}_{\mathbf{Canada}} = \sum_{i=1}^{n} \mathbf{CTe} + \sum_{i=1}^{n} \mathbf{CSe} + \sum_{i=1}^{n} \mathbf{COt}$$

TAC_{CANADA}	=	Total Additional Cost in Canada
CTe	=	Cost of testing
CSe	=	Cost of segregation
COt	=	Other costs
n	=	Number of stakeholders

In the case of the EU, the flaxseed industry also incurred extra cost related to the Triffid event. The total additional cost in the flaxseed supply chain on EU side are associated with; decrease in the profit received by linseed oil producers, recalled products containing GM flaxseed, destroyed products that tested positive for GM flaxseed, storage cost of product removed from the supply chain due to uncertainty in the market, customers' claims for having to deal with GM positive products and shutting down operations due to lack of flaxseed. By summing up these costs, Total Additional Cost (TAC_{EU}) associated with the supply chain of the EU can be estimated[37]. In addition, due to tighter supply condition and higher prices, flaxseed imports to EU changed considerably.

[37] No legal fees or liability payments are included in estimating the Total Additional Cost of the EU.

$$\mathbf{TAC_{EU}} = \sum_{i=1}^{n} \mathbf{Dpr} + \sum_{i=1}^{n} \mathbf{Rp} + \sum_{i=1}^{n} \mathbf{Dp} + \sum_{i=1}^{n} \mathbf{Sc} + \sum_{i=1}^{n} \mathbf{Cc} + \sum_{i=1}^{n} \mathbf{Sdo}$$

TAC_{EU}	=	Total Additional Cost in the EU
Dpr	=	Decrease in profit
Rp	=	Recalled products
Dp	=	Destroyed products
Sc	=	Storage cost (blocked products)
Cc	=	Customers' claims
Sdo	=	Shutting down operations
n	=	Number of stakeholders

Section 5.3 illustrates the different costs borne by different stakeholders. Furthermore, it gives a detailed explanation of the stakeholders along the supply chain. In addition, the section explains how the estimation of additional costs along the supply chain is undertaken for this thesis.

5.3 Cost borne by different stakeholders in Canada due to CDC Triffid event

5.3.1 Plant breeders

There are three main flax breeding programmes in Canada. These are the Agriculture and Agri-food Canada programme located at the Morden Research Centre in Manitoba, the Crop Development Centre (CDC) programme located at University of Saskatchewan, and the Viterra programme located in Vegreville, Alberta (Murrell, 2011). The CDC's flax breeding programme has been a major provider of flax varieties to farmers and the Agri-food industry in western Canada. More than 80 percent of flax acres in western Canada are planted with CDC flax varieties (Murrell, 2010).

According to Statistics Canada (2010d), two flaxseed varieties from the Crop Development Centre tested positive for trace amounts of CDC Triffid. Therefore, all pedigreed seed stocks of CDC Mons and CDC Normandy will be deregistered by the CFIA. In addition, CDC Bethune, CDC Sanctuary and CDC Sorrel have also shown traces of GM material and will be re-constituted from single plants of the pre-breeder seed (Murrell, 2010). Testing leaf tissue for FP967 and maintaining a winter nursery in New Zealand for these three varieties adds another set of costs to the flax breeding programmes (Booker, 2010). Further, the Crop Development Centre is planning to develop their own lab to test for CDC Triffid by 2010. At present, they are testing flaxseed for GM in private labs[38]. Furthermore, there are opportunity costs of professional time and effort of the plant breeders which is expended to deal with this issue. According to Murrell (2010), the loss of reputation for the CDC and the loss of good will is also a significant loss. Table 5.1 shows the estimated additional cost borne by Crop Development Centre due to the CDC Triffid event.

Table 5.1: Additional Cost borne by flax breeders in 2009/2010 crop year[39]

Cost Category	Cost ($)
Breeder seed testing	28 000
Testing leaf tissue for CDC Triffid	40 000
Maintaining winter nursery in New Zealand	10 000
Starting a Lab to test CDC Triffid	50 000
Total cost	128 000

Source: Booker (2010), Murrell (2010)

Therefore, as explained by Booker (2010) and Murrell (2010), the CDC spent $ 128 000 in 2009/2010 to overcome the CDC Triffid event.

[38] 20/20 Seed Labs Inc., BioDiagnostics Inc., BioVision Seed Labs, Discovery Seed Labs Ltd, DNA LandMarks Inc., Eurofins GeneScan Inc., Genserve Laboratories, Saskatchewan Research Council (SRC), OMIC USA Inc., Quantum Biosciences Inc., SGS Brookings, SGS Winnipeg (Flax Council of Canada, 2010g).

[39] 01, August 2009 to 31, July 2010 is considered as 2009/2010 crop year.

5.3.2 Seed suppliers

SeCan is the largest supplier of certified flaxseed to western Canadian farmers. It is a private, non-profit, member-owned corporation (SeCan, 2008). The members of SeCan are Selected, Foundation, Registered and Certified[40] Seed Growers. SeCan carries nearly nine flax varieties with the most popular varieties being CDC Bethune and CDC Sorrel. There are around 85 Certified Seed Growers, 37 Registered Seed Growers, 12 Foundation Seed Growers and two Selected Seed Growers of these two varieties (SeCan, 2008). According to Booker (2010), the total quantity of certified CDC Bethune and CDC Sorrel seed sold by SeCan in 2010 was 6 903 tonnes. The Canadian Seed Growers Association recommends that commercial seed producers should test each 10 tonnes of their pedigreed seed for CDC Triffid. The cost of testing one sample was $240. This adds extra cost to commercial seed producers. As CDC varieties represent 80 percent of the total flaxseed production on the prairies, the extra cost associated with these two varieties can be considered as the main extra costs faced by seed producers due to CDC Triffid event. Therefore, approximately $165,672 likely has been spent by commercial seed growers for seed testing. See Table 5.2. This is an underestimated value as the actual amount of certified seed sold in 2010 is higher if other flaxseed varieties are also considered.

Table 5.2: Additional cost of testing certified flaxseed

Cost Category	Cost ($)
Total cost of testing certified seed in 2010	(6903/10)*240=$165,672

Source: Author's calculations

[40] Selected, Foundation and Registered seed are usually non-commercial seed classes available as planting stocks to certified seed production. They are grown in limited quantities and monitored for varietal purity. Certified seeds are sold to commercial farmers for general crop production (Copeland and MacDonald, 2001).

Furthermore, the CDC Triffid event adds another set of costs to seed producers due to intensive measures taken to prevent comingling of GM seeds at farm level. In section 5.3.4.2 the cost of segregation faced by certified seed suppliers is estimated.

5.3.3 Producers

In this thesis any person operating a farm in western Canada who is engaged in the production of, and marketing of, flaxseed is considered as a producer. In addition, this thesis does not distinguish between conventional flaxseed producers[41] and organic flaxseed producers. The number of registered flaxseed producers in Saskatchewan is 12,000 (SaskFlax, 2009c) and in Manitoba the number of producers is 500 (Manitoba Flax Growers Association, 2011).

In the 2009/2010 crop year some producers found CDC Triffid in their crops once they were harvested and it was not possible to prevent comingling. The cost they incurred were primarily the cost of testing seed lots[42]. Depending on the quantity of their production, they may have to do several tests. According to SaskFlax (2010), each producer should have submitted a sample of 1 kg for every 75 to 125 tonnes (3,000 to 5,000 bushels) of a producer's total flax inventory. If producers have more than 125 tonnes of flaxseed they should test samples of each additional 125 tonnes of flax seed. The cost of each test was \$105 up to September 1st 2010. From September 1, 2010 producers have had to pay \$240 for intensive testing of four subsamples from an initial two kg sample. All four subsamples should be negative to consider a seed lot to be CDC Triffid free (SaskFlax, 2010). According to the Flax Council of Canada (2010g), the total number of tests conducted at the producer level was 6000 in 2010.

To regain their largest market, the Canadian flax industry has been encouraging producers to use certified seed for the 2010 crop. Initially, the Flax Council of Canada announced that farmers must use certified seed, but later found that some certified seed was also contaminated with CDC

[41] In conventional flaxseed production chemical fertilisers, pesticides and herbicides are used while in organic flaxseed production no such inputs are used.

[42] However, there are number of other opportunity costs including time spent on taking samples, bringing samples to relevant laboratories for testing or cost of mailing samples to laboratories, etc.

Triffid. Farmers were subsequently allowed to use their own farm saved seed for 2010, but only after testing for CDC Triffid. Producers have to test twice for CDC Triffid if their seed is held over for sowing, i.e before cleaning the seed lot and after cleaning the seed lot. According to the 'Industry Stewardship Programme for Farm Saved Seed' announced by Flax Council of Canada (2010f), before cleaning a seed lot a producer has to undertake a 1x 60g test which costs $105 per each 20 tonnes. If it shows negative results, after cleaning they have to do 4 x 60g tests which costs $240 per each 20 tonnes. This is an extra cost in their production. If farmer's saved seeds test positive for CDC Triffid, the farmers must buy certified seed.

Using a seed rate of 37.5kg/ha and a total seeded area of 431000 ha the total amount of flaxseed needed for sowing in 2010 was calculated as 16162 tonnes. Out of that amount, 6903 tonnes came from certified seed producers. Therefore, amount of farm saved seed used was 9259 tonnes for 2010/2011 crop year. The size of the sample for testing was 20 tonnes. Therefore, number of samples tested for farm saved seed should be 462. As of August 2010, producers have tested 6000 samples of flaxseed (Flax Council of Canada, 2010g). The number of tests done for retained seed was 462. Therefore, number of tests done for 2009 crop should be 5538. Table 5.3 shows the additional cost borne by producers in 2009/2010.

Table 5.3: Cost of testing incurred by producers in 2009/2010

Cost Category	**Cost ($)**
Cost of test 1for farm saved seed	(((37.5*431000)/1000)-6903)/20* 105 = $48510
Cost of test 2 for farm saved seed	(((37.5*431000)/1000)-6903)/20*240 = $110880
Total cost of testing farm saved seed in 2010	$ 48510+ $110880 = $159390
Total cost of testing 2009/2010 crop	(6000-462)*105 = $581490
Total cost of testing	$740 880

Source: Author's calculations

In the 2010/2011 crop year, potential production is forecast to be 537 000 tonnes (Statistics Canada, 2010f). The sample size is 125 tonnes and cost per sample is $240[43]. If all the production is subjected to sampling and testing as required by the Protocol, the total cost of testing 2010/2011crop can be calculated. See table 5.4.

Table 5.4: Cost of testing incurred by producers in 2010/2011

Cost Category	**Cost ($)**
Total cost of testing 2010/2011 crop	(537000/125)*240 = $1 031 040

Source: Author's calculations

Therefore, in 2010/2011 crop year the cost of testing the crop will be $1.03 million. Other than the cost of testing, producers may have a number of other costs associated with a GM flax event. For example, some of the producers rent storage at primary elevators. Therefore, if the test results are delayed, producers have to pay an extra storage cost as well. In addition, if producer carry-over stocks have increased due to CDC Triffid being present it adds extra cost for producers. Similarly, if the test results proved to be positive, producers get lower prices compare to flax seed having negative test results. This can also be considered as a cost for producers. To prevent comingling of CDC Triffid, farmers have to clean their harvesting equipments, storage bins and trucks used for transporting. In addition, there is an opportunity cost of time spent for sampling and also a cost of mailing/courier samples to relevant laboratories. This increases total cost of handling and transporting of flaxseed for producers. In Section 5.3.4.2 the cost of segregation at the producer level is estimated using the available literature.

5.3.4 Elevator companies

Based on their functions, elevator companies can be divided into primary collection, process, terminal or transfer elevators. There are few processors in the supply chain. Primary elevators purchase and take delivery of flaxseed from producers on behalf of grain handling companies.

[43] From January 01, 2011 producers will receive a subsidy of $ 100 for every test from the Flax Council of Canada.

They may clean, weigh, sample, grade and load flaxseed before shipping it through the rail system to terminals at Thunder Bay and Vancouver or delivering to domestic processors. Farmer owned trucks are generally used to deliver flaxseed to primary elevators. To transport flaxseed to terminal elevators, the rail system, particularly the Canadian National Railway, the Canadian Pacific Railway and the British Colombia Railway, is used. Flaxseed moved eastward through the Great Lakes and the St Lawrence Seaway system is shipped in laker vessels (Veeman and Veeman, 1984). These laker vessels must off load the flaxseed and reload it on to ocean going vessels prior to export. Table 5.5 illustrates that most of the flaxseed is shipped from Thunder Bay. It is the most direct route to the EU.

Table 5.5: Export of flax seed by clearance sector in 2008/2009 (000's of tonnes)

Country	Pacific (Vancouver)	Thunder Bay	Eastern (Sorel, Precscot)	Prairies	Total
Western Europe					
Belgium	-	271	124.1	-	395.1
France	-	8.4	-	-	8.4
Germany	-	19.3	-	-	19.3
Total	**-**	**298.6**	**124.1**	**-**	**422.7**
Asia					
China	18.1	-	-	-	18.1
Japan	8	-	-	-	8
Total	**26.1**	**-**	**-**	**-**	**26.1**
USA	0.1	-	0.2	81.1	81.4
Grand Total	**26.2**	**298.6**	**124.3**	**81.1**	**530.2**

Source: Canadian Grain Commission (2009c)

According to Canadian Grain Commission (2010e) there are 394 licensed elevators in the country. 56 percent of the elevators are owned by four companies. Most of the elevators are located in Saskatchewan and most of the primary elevators are owned by Viterra Inc. (101 elevators), Richardson Pioneer Ltd (54), Paterson Grain (35) and Cargill Ltd (34). Table 5.6 shows the distribution of elevators in different provinces.

Table 5.6: Number and type of elevators in different provinces

Elevator Type	Manitoba	Saskatchewan	Alberta	B.C	Ontario	Quebec	Montreal	Total
Primary	77	162	79	5	0	0	0	323
Process	11	20	11	1	1	0	0	44
Terminal	1	0	0	7	7	0	0	15
Transfer	0	0	0	0	5	6	1	12
Total	87	185	87	13	13	6	1	394

Source: Canadian Grain Commission (2010e)

As a requirement of the *Canada Grain Act*, elevators must be licensed by the Canadian Grain Commission. As a condition of licensing, an elevator must provide a security deposit to the Canadian Grain Commission. This risk reduction instrument is used to compensate flaxseed producers in the event they are not paid for the flaxseed they deliver to the licensed company (CGC, 2010f). Elevators licensed by the Canadian Grain Commission can charge for grain handling services and then deduct these costs from grain delivery payment of producers. Primary, terminal, transfer and process elevator charges including; elevation, removal of dockage, storage, cleaning as requested by the owner of the grain or screenings, drying as requested by the owner of the grain or screenings, blending and other services performed by the elevator company may be deducted. After the CDC Triffid event, grain handling companies have to handle flaxseed in a way that minimises comingling of CDC Triffid. This adds an extra cost of segregation to total handling cost.

5.3.4.1 Cost of testing for CDC Triffid at elevator level

Cost of testing is one of the main additional costs borne by grain handling companies due to the GM event. According to the sampling and testing Protocol, all the flaxseed that moves along the supply chain should be tested for CDC Triffid flax. Table 5.7 shows the volumes of flaxseed exported since the introduction of Protocol to September, 2010.

Table 5.7: Changes in flaxseed export after the CDC Triffid issue (000's of tonnes)

	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10
EU	0	0	54.3	33.8	55.4	0	15.7	60.6	11.3	27.7	0	39.8
China	0	11	55.2	19.2	0	43.7	27.4	0	8.8	42.3	0	0
US	8.3	10.3	19.6	10.6	7.1	15.6	8.4	14	13.8	11.8	9	3.3
Japan	0	0	0	0	0	1.8	0	0	0	0	0	0.8
Total	8.3	21.3	129.1	63.6	62.5	61.1	51.5	74.6	33.9	81.8	9	43.9

Source: CGC (2008 - 2010)

Using these export volumes and the sample sizes assigned by the Protocol, the cost of testing for CDC Triffid at the elevator level can be estimated. Here, two scenarios have been considered. Firstly, the testing cost is estimated for total exports to all the countries. Secondly, if export volumes to EU can be separated at the elevator level, testing can be done only for that amount of flaxseed.

From October 2009 to March 2010, grain handling companies have done rail car testing for CDC Triffid when the seed moves from a primary elevator to terminal elevators. Since March 2010, after the revising of the Protocol, grain handling companies have also tested for CDC Triffid when the flaxseed is unloaded into silos at terminal elevators. Based on this information, the total cost associated with testing at rail cars and silos can be estimated. The sample size at the rail car level is 500 tonnes and sample size at silo level is 1000 tonnes. The cost of testing one sample is \$240. Table 5.8 shows the results.

Table 5.8: Costs associated with testing flaxseed at railcars and silos

Time period	Cost of rail car tests (EU only)	Cost of rail car tests (all the countries including EU)	Cost of silo tests (EU only)	Total cost (EU only)	Total cost (exporting to all the countries)
October-2009 to February-2010	(143500/500)* 240 = $68880	(284800/500)*240 = $136560	-	$68880	$136560
March-2010 to September-2010	(155100/500) *240 =$74400	(355800/500)*240 = $170640	(155100/1000)*240 =$37200	$111600	$207840
Total cost	$143 280	$307 200	$37 200	$180 480	$344 400

Source: Author’s calculations

The results reveal that flaxseed exported to EU since the introduction of the Protocol was associated with extra testing cost of $180 480. If all the exporting countries including EU were considered, the extra cost of testing was $344 400. During this period, from October 2009 to September 2010, the total flaxseed exported was 640 600 tonnes. Therefore, the additional cost of testing per tonne of flaxseed at elevator level was $0.53. In the case of exports to EU, the cost of testing per tonne of flaxseed was $0.60. In the 2010/2011 crop year 550 000 tonnes of flaxseed is forecast to be exported (Agriculture and Agri-food Canada, 2010). If 73 percent of that amount will be exported to EU, the total cost of testing at the rail car and silo level can be estimated. See Table 5.9.

Table 5.9: Cost of testing rail cars and silos for 2010/2011 crop

Cost Category	Cost $
Cost of rail car testing of total exports	(550000/500)*240 = $264000
Cost of rail car testing of exports to EU	((550000*.73)/500)*240 = $192720
Cost of silo testing to exports to EU	((550000*.73)/1000)*240 = $96360
Total cost of testing to exports to EU	$289080

Source: Author’s calculations

The results reveal that in 2010/2011, if exports to EU become 73 percent of total exports, the flaxseed industry has to pay approximately $0.29 million for testing according to procedures laid out in the Protocol.

5.3.4.2 Cost of segregation

Other than testing costs, grain handling companies incur costs associated with differentiating CDC Triffid containing and CDC Triffid free seed lots. The terms identity preservation (IP), segregation and traceability are used in the literature to describe differentiation of GM and GM-free products. According to EU's Directorate General for Agriculture (2003) segregating implies setting up and monitoring of separate production and distribution channels for GM and non-GM products. The focus of segregating is to ensure that the special trait is not commingled with other products (Smyth and Phillips, 2002b). According to Buckwell et al. (1998), identity preservation (IP) is a system of crop management and supply chain management that allows the source and/or nature of material to be identified along the supply chain. In the case of CDC Triffid, the differentiation has the characteristics of both IP and segregation. Prevention of comingling of CDC Triffid is a part of government regulations for managing the supply chain for flaxseed. It was precipitated by the consumer requirements in the EU and the liability of grain handling companies. The present flaxseed differentiation system allows identification of the CDC Triffid free flax in the supply chain due to the sampling of product at different stages of the supply chain. As explained in Section 3.2, grain handling companies keep a sample of each producer delivery at the primary elevator level. At the rail car level and terminal elevator level samples must also be kept for further testing if necessary. If comingling is identified, these samples would be used to determine the source of comingling in the supply chain.

To estimate the cost of differentiating CDC Triffid free flaxseed, the available data on cost of segregation and cost of IP for other grains are used as a proxy. According to Lin and Johnson (2003), segregation could add about US$0.22 per bushel to the cost of handling non-biotech corn from country elevators to export in United States in 2000/2001 crop year. When adjusted for inflation[44] this value becomes US$0.30 in 2009. Lin and Johnson (2003) also report the result of

[44] Producer Price Index (PPI) for all commodities in USA: 2009= 178.1, 2003=139.5, 2001=128.1, 1982=100 (US Dept. of Labour, 2009).

a survey done by Protein Technologies International which estimated the cost of segregation for 2001 nonbiotech soybeans at US$0.18 per bushel from country elevators to export elevators. Adjusted value of US$0.18 for inflation is US$0.25 in 2009. By taking the average value of these two i.e. US$0.265 and assuming that value is similar to segregation cost for Canadian flaxseed, the total cost of segregating flaxseed from country elevators to export elevators can be estimated. When converted to Canadian Dollars US$0.265 was equal to CA$0.278[45] in 2009 (Bank of Canada, 2010).

As one flaxseed bushel equals to 25. 4 kg (1 flaxseed bushel= 56 lb), cost of segregating of one tonne of flaxseed can be estimated to CA$ 10.94 ((0.278/25.4)* 1000). However, the level of tolerance in non-biotech corn is five percent while level of tolerance in GM free flax is 0.01 percent. As explained by Isaac et al. (2005) ensuring this high level of purity would be unacceptably costly and infeasible. Therefore, the cost of segregation found here is likely an underestimated value.

There are a number of other studies that have estimated the cost of segregating non-GM crops and those values can be used when deciding the proxy value for cost of flaxseed segregation. Buckwell et al. (1998), have estimated IP costs for number of crops in the US, Brazil and Canada. Out of these findings, the IP costs for oilseed rape in Canada is used in estimating a proxy value in this thesis as it is closer to the cost of segregation provided by Lin and Johnson (2003). According to Buckwell et al. (1998), the average cost of IP for the farm level, transport and storage stages of the supply chain for oilseed rape in Canada in 1998 was US$8.13 per tonne. Here, cost of testing was not considered as it was estimated as a separate cost component in the present research. When first adjusted for inflation[46] and then converted to CA$ this becomes CA$10.88 in 2009 (8.13*(121.1/95)*1.05).

[45] 1 USD = CA$ 1.05 in 2009 (Bank of Canada, 2010).

[46] Farm Product Price Index of Canada: 1997=100, 2000=95, 2004=99.4, 2008=121.1 (Statistics Canada, 2010g).

Huygen et al. (2004) provides an estimate of IP costs in the supply chain for wheat in Canada. See Table 5.10. In that research, different IP costs have been estimated for different tolerance levels of GM wheat in GM free wheat.

Table 5.10: Cost of differentiating GM free wheat in Canada

Cost Category	**Cost at Tolerance levels (CA$ per tonne)**	
Farm IP cost	**5%**	**0.10%**
Volunteer Control	0.84	5.15
Cleaning[a]		
Seeder	0.02	0.08
Combine	0.06	0.26
Truck	0.01	0.03
Semi	0.01	0.03
Bin	0.01	0.08
Dryer	0.01	0.04
Auger	0*	0.02
Combine flush	0.02	0.04
Total farm IP cost	**0.98**	**5.73**
Primary elevator IP cost		
Clean[b] receiving	0*	0.02
Clean storage	0.01	0.02
Clean shipping	0*	0.01
Capital expenditure	0.05	0.19
Total primary elevator IP cost	**0.06**	**0.24**
Terminal elevator IP cost		
Clean[c] receiving	0.01	0.02
Clean storage	0*	0.01
Clean shipping	0*	0.01
Capital expenditure	0.01	0.05
Total terminal elevator IP cost	**0.02**	**0.09**
Fixed IP: elevators (training, legal costs)	0.30	0.30
Cost of coordination at all levels	3.75	3.75
Total IP cost	**5.11**	**10.11**

Source: Huygen et al. (2004)

([a] $15/hour wage applies for mechanical cleaning, [b] $16/hour wage applies for mechanical cleaning, [c] $27.29/hour wage applies for mechanical cleaning)

The results of the research reveal that when threshold level become more stringent, IP cost increase non-linearly. Out of the range of IP costs estimated, costs related to a 0.1 percent tolerance level was chosen as applicable for this research. Huygen et al. (2004) clearly show that when the level of tolerance decreases, the IP costs increases considerably. In particular, cost of volunteer control increased significantly when the tolerance level decreases from five percent to 0.1 percent. Therefore, using the IP cost values given for 0.1 percent tolerance level to estimate the cost of segregating flaxseed having 0.01 percent tolerance level may lead to an underestimation. According to Huygen et al. (2004), total IP cost of moving wheat from primary elevator to export elevator was CA$4.38 per tonne at 0.1 percent tolerance level. When adjusted for inflation it becomes CA$5.33 in 2008 (4.38*(121.1/99.4)).

From the segregating costs found in literature, the value given by Huygen et al. (2004) was used as the proxy value for the present study because it is more closely related to the Canadian flaxseed supply chain. However, the values given by Lin and Johnson (2003) and Buckwell et al. (1998) were helpful in understanding the approximate cost of segregating GM free grains in a supply chain. It is interesting to note that segregation costs in the present study are the costs of preventing comingling of flaxseed lots with GM seeds higher than 0.01 percent and seed lots with GM seeds less than 0.01 percent. Therefore, the CDC Triffid event has created new scenario in segregation costs in GM and non-GM grains.

Since the introduction of the Protocol, i.e from October 2009 to September 2010, Canada has exported 640.6 thousand tonnes of flaxseed (CGC, 2008-2010). If total exported flaxseed has been subjected to the process of segregation along the supply chain from primary elevators up to terminal elevators, the total cost of segregation at 0.01 percent level can be calculated. If flaxseed exported solely to EU was subjected to segregation, the cost can be calculated in a similar fashion. During the period being considered, total exports to the EU were 298600 tonnes (CGC, 2010c). The results reveal that the total cost of segregation from primary elevators to terminal elevators in 2009/2010 was $3 414 398 for total exports and $1 591 538 for exports to the EU; see Table 5.11.

Table 5.11: Cost of segregation from primary elevators to terminal elevators

Cost Category	Cost ($)
Total cost of segregation from primary elevators to terminal elevators in 2009/2010 (total exports)	640600* 5.33= $3 414 398
Total cost of segregation from primary elevators to terminal elevators in 2009/2010 (exports to EU only)	298600* 5.33 = $1 591 538

Source: Author’s calculations

For the 2010/2011 crop year cost of segregation from primary elevator to terminal elevator can be estimated based on forecasted export of 550 000 tonnes. It is assumed that out of the total exports, 73 percent will be exported to the EU in 2010/2011. See Table 5.12.

Table 5.12: Cost of segregation 2010/2011 exports

Cost Category	Cost ($)
Total cost of segregation of total export	$ (550000*5.33) = CA$2 931 500
Total cost of segregation of exports to the EU	$ (550000*.73)*5.33 = CA$2 139 995

Source: Author’s calculations

Table 5.12 illustrates that the total cost of segregation of total export will be $2 931 500 and the total cost of segregation of exports to EU will be $2 139 995 in 2010/2011.

When the Protocol was introduced in October 2009, the 2009/2010 crop was, for most part, being stored in producer bins on farm. If producers try to prevent comingling by cleaning their trucks when transporting flaxseed to primary elevator that can be considered as cost of segregation at farm level for 2009/2010 crop. According to Huygen et al. (2004), cleaning trucks cost CA$ 0.03 and when adjusted for inflation it becomes CA$0.036 in 2008 (0.03*(121.1/99.4)). After introducing the Protocol producers have tested 5538 samples of flaxseed at farm level. Every sample represents 125 tonnes of flaxseed. These values can be used to estimate the cost of segregation while transporting to primary elevators. See Table 5.13.

Table 5.13: Total cost of segregation at primary elevator level in 2009/2010

Cost Category	Cost ($)
Total cost of segregation at farm level	(5538* 125)*0.036 = $24 291

Source: Authors calculations

Therefore, producers have spent $24 291 in 2009/2010, in order to prevent further comingling of CDC Triffid while transporting their flaxseed to primary elevators. Considering forecasted production for 2010/2011 crop year, potential segregation cost at farm level can be calculated. According to the proxy value given by Huygen et al (2004), cost of segregating flaxseed at farm level is CA$6.98/tonne (5.73*(121.1/99.4)). The forecasted production is 537 000 tonnes (Statistics Canada, 2010f). Therefore, the cost of segregating total production at the farm level in 2010/2011 will be $3 748 260; see Table 5.14.

Table 5.14: Total cost of segregation at farm level in 2010/2011

Cost Category	Cost ($)
Cost of segregating total production	537 000*6.98 = $3 748 260

Source: Author's calculations

Therefore, it is apparent that cost of segregation increases considerably if farm level costs are included. However, as these costs are estimated for 0.1 percent tolerance level they may give underestimated values for a 0.01 percent tolerance level. Based on the farm level segregation cost given by Huygen et al. (2004), the additional cost borne by certified seed suppliers can also be estimated; see Table 5.15. In 2009/2010 commercial seed producers have produced 6903 tonnes of flaxseed.

Table 5.15: Total cost of segregation of commercial seed production

Cost Category	Cost ($)
Cost of segregating commercial seed production	6903*6.98 = $48 183

Source: Author's calculations

Therefore, in 2009/2010 the cost of segregation incurred by commercial seed producers was $48 183. However, this may be an underestimated value as certified seed production is more intensive than commercial flaxseed growing and thus prevention of comingling may be more costly in certified seed production.

As explained by Smyth and Phillips (2001), the point of co-mingling determination will greatly impact the final cost of detection. Once comingling is determined, it is necessary to remove that seed lot from the flaxseed supply chain for the EU. If co-mingling is determined on-farm or at an inland terminal, the cost would be substantially lower than if detection was made at laker vessels or at ocean-going vessel. The reason the cost would be lower is that the volume of co-mingled flaxseed is lower on farm or at the inland terminal than in vessels (Smyth and Phillips, 2001). In the present study, costs that arise due to a determination of comingling is not estimated due to lack of information[47].

Another cost grain handling companies may face is the demurrage cost if test results are delayed. Due to lack of transparency in the testing process, it was not possible to estimate the demurrage cost due to delays in tests. Further, if exported seed lots turn out to be positive for CDC Triffid when tested at ports in the EU, there would be another set of costs for importers. Since revising the Protocol in March 2010, there were no tests done at the EU ports. However, there is a possibility of testing at the EU ports as there is no clear indication in the Protocol regarding testing in the EU side of the supply chain.

[47] The cost of having a test at terminal elevator detect CDC Triffid may result in a reduced value for a large quantity of flaxseed arising from a small amount of CDC Triffid.

5.3.5 Institutions in flax seed industry

There are number of institutions supporting the smooth functioning of the flaxseed supply chain. Even though they do not physically possess the flaxseed at any point, they play a significant role in flaxseed industry of Canada. The CDC Triffid event has increased the cost associated with their involvement in the industry. The cost borne by institutions due to the CDC Triffid event is considered under the category of 'other cost (COt)' in the model.

5.3.5.1 The Canadian Grain Commission (CGC)

The Canadian Grain Commission is a federal government agency. It is the regulator of Canada's grain handling industry, the official certifier of Canadian grain and the scientific research organisation on grain quality for Canada. The Canadian Grain Commission protects the rights of Canadian grain producers when they deliver their grain to licensed grain handling companies and grain dealers (CGC, 2010g). The main cost face by CGC in the CDC Triffid event was the cost of developing and monitoring the Protocol. CGC official had to visit EU to propose the Protocol. With the implementation of Protocol, CGC officials are responsible for the sampling and testing process at the silo level. Opportunity cost of time and effort of CGC official spent on CDC Triffid event would be a considerable amount if calculated. However, due to lack of information, cost borne by CGC in the CDC Triffid event was not estimated in this study.

5.3.5.2 The Flax Council of Canada

The Flax Council of Canada is an organisation which develops and support markets that will lead to increased flax production and exports of flax and flax products. It was established in 1986, and governed by a Board of Directors comprised of producers, exporters, manufacturers and grain companies. The Flax Council played a major role in the response to the CDC Triffid event. There would be a high opportunity cost of time and effort of Flax Council officials. However, confidentiality in the industry hinders estimation of the extra costs borne by Flax Council due to CDC Triffid event. However, according to the Flax Council of Canada (2010h), from January 1, 2011, they will provide $1.5 million to cover a portion of western Canadian flax producers' and seed growers' costs of tests to detect the presence of CDC Triffid in seed. As of January 1, approved labs will give producers a discount of 50 percent of the regular cost of testing pedigree and farm-saved seed, up to a maximum of $100 per sample. The labs will be reimbursed by the

Flax Council for the discounts from the funds of the new initiative. However, this new cost is not included in the cost estimation of present study because the new cost represents 2011/2012 crop year.

5.3.5.3 The Saskatchewan Flax Development Commission (SaskFlax)

Saskatchewan Flax Development Commission (SaskFlax) is an agency established under the Agri-food Act 2004 of Agri-food Council of Government of Saskatchewan. SaskFlax, represents over 12,000 registered flax producers in Saskatchewan. It aims to enhance flax production in the province to gain the maximum return to producers. The main areas of concern are market development, research, leadership and communication in the industry. A mandatory check-off system (but refundable) enables the Commission to support market facilitation activities of the flaxseed and flax fibre industries in the province (Saskflax, 2010).

Adventitious presence of CDC Triffid has already caused considerable extra expenditure for SaskFlax. There have been three Conference Calls conducted by SaskFlax to communicate with producers and one Conference Call to discuss the issue with relevant officers of the Government of Saskatchewan. Further, a newsletter explaining the CDC Triffid issue and how to take a representative sample has been distributed among 10 500 flaxseed producers in Saskatchewan. In addition, SaskFlax has reserved 40 hours a month solely to talk to producers regarding the updates pertaining to the presence of CDC Triffid over the phone. The total cost associated with CDC Triffid event to SaskFlax in 2009/2010 was $70900 (Braun, 2010). In general, SaskFlax expects to spend $100,000 in 2010-2011 to deal with the CDC Triffid issue (Braun, 2010).

5.3.5.4 Manitoba Flax Growers Association

Manitoba Flax Growers Association is established under the Regulation 119/2008 of the Agricultural Producers’ Organisation Funding Act of the Government of Manitoba. The purpose of this regulation is to enable the association to collect money from flax producers and solin producers to promote and financially support initiatives in the areas of production, marketing, extension, education and research (Government of Manitoba, 2008). There are approximately 500 flaxseed producers in Manitoba (Manitoba Flax Growers Association, 2011). Being a new and small association they depended for the most part, on the Flax Council of Canada to deal with the Triffid event. Therefore, the cost borne by Manitoba Flax Growers Association in the case of Triffid event was considered as negligible in the present study.

5.3.5.5 Agriculture and Agri-food Canada

According to Statistics Canada (2010e), Agriculture and Agri-food Canada has pledged up to $5.9 million in funding to the Flax Council of Canada to help create new flaxseed varieties and to develop an improved method for flaxseed testing. Out of that fund, $1.9 million will come from the Canadian Agricultural Adaptation Program (CAAP) to develop sampling and testing methods to identify the presence of genetically modified flaxseed in Canadian flaxseed exports.

5.4 Total Additional Cost associated with CDC Triffid event in Canada

When additional costs incur by stakeholders are summed, the total additional cost faced by the flaxseed industry after the CDC Triffid event is estimated. Two scenarios were considered i.e, exports to the EU only and total exports to all the countries; see Table 5.16.

Table 5.16: Total Additional Cost to the Flaxseed Industry of Canada in 2009/2010 ($)

Stakeholder	Cost category	Scenario 1 Exports to EU	Scenario 2 Total exports
Flaxseed Breeder (CDC)	CTe	28 000	28 000
	COt	100 000	100 000
	Total	128 000	128 000
Certified seed suppliers (Secan)	CTe	165 672	165 672
	CSe	48 183	48 183
	Total	213 855	213 855
Producer	CTe	740 880	740 880
	CSe	24 291	24 291
	Total	765 171	765 171
Grain elevator companies	CTe	180 480	344 400
	CSe	1 940 900	4 163 900
	Total	2 121 380	4 508 300
SaskFlax	COt	70 900	70 900
Agriculture and Agri-food Canada	COt	1 900 000	1 900 000
Total additional cost (TAC)		**5 199 306**	**7 586 226**

Source: Author's calculations

According to the estimations given in the Table 5.16, it is apparent that CDC Triffid event has caused significant additional cost to the industry. In the case of export to the EU only (scenario 1), additional cost was approximately $5 million and in the case of total exports to all the countries it was approximately $7.5 million.

In the case of total exports to all the countries total cost of testing was $1 278 952 and total cost of segregation was $4 236 374. The additional cost borne by grain handling companies was the highest cost among the stakeholders in 2009/2010. Second highest cost was borne by Agriculture and Agri-food Canada. However, there is a lack of information about the cost borne by a number of institutions that play a major role in the flaxseed industry. Also, most of the estimations were based on tolerance level higher than 0.01 percent. Therefore, the total cost figures given here are underestimated values rather than the actual cost to the industry.

For 2010/2011 crop year total additional cost is estimated based on the forecasted total exports by CGC (2000-2010). Table 5.17 illustrates the results. It clearly shows that cost of testing for producers has increased compare to 2009/2010. The additional cost borne by producers is the highest cost among the stakeholders in 2010/2011.

Table 5.17: Total Additional Cost to the Flaxseed Industry of Canada in 2010/2011

Stakeholder	**Cost Category**	**Cost $**	
		Exports to EU	**Total exports**
Flaxseed Breeder (CDC)	CTe	28 000	28 000
	COt	50 000	50 000
	Total	78 000	78 000
Certified seed supplier (SECAN)	CTe	165 672	165 672
	CSe	48 183	48 183
	Total	213 855	213 855
Producer	CTe	1 031 040	1 031 040
	CSe	3 748 260	3 748 260
	Total	4 779 300	4 779 300
Grain elevator companies	CTe	289 080	264 000
	CSe	2 139 995	2 931 500
	Total	2 429 075	3 195 500
SaskFlax	COt	100 000	100 000
Total additional cost (TAC)		**7 600 230**	**8 366 655**

Source: Authors calculations

According to the results of the Table 5.17, the CDC Triffid event will cost an additional $7.6 million to the flaxseed industry in 2010/2011 if only exports to EU are considered. If total flaxseed export is considered the additional cost will be $8.3 million. It is interesting to see that flaxseed producers incur the highest additional cost in 2010/2011. This is mainly due to the higher cost of segregation at farm level. Producers have to spend a considerable amount of money to prevent comingling in the new crop. In addition, the cost of testing increased in 2010/2011 due to the mandatory 4x 60g testing requirement of Flax Council of Canada. The basic assumption here is exports to EU will be restored in 2010/2011. Therefore, it is apparent that even if flaxseed to EU become normal the industry would incur considerable amount of cost due to the strict regime put in place to satisfy the terms of the Protocol.

5.5 Changes in revenue due to CDC Triffid event

Other than the cost explained so far, there is a change in revenue due to the CDC Triffid event. The main reasons for the change in revenue are the changes in export quantities and decrease in prices. To estimate the change, average revenue from flaxseed exports from the 2004/2005 crop year to the 2008/2009 crop year was used as a starting point. By taking the difference in average total revenue of those years and total revenue of 2009/2010 crop year, the loss/gain is calculated. Average flaxseed export to the EU out of total exports was approximately 70 percent. However, in 2009/2010 the proportion was reduced to 35 percent due to the CDC Triffid event. That has caused $57 798 600 loss of revenue to flaxseed industry of Canada; see Table 5.18.

Table 5.18: Change in revenue in export to EU only

Exports to EU	Tonnes	Price ($/tonne)	Revenue ($)
2004/2005	315000	442	139230000
2005/2006	355000	259	91945000
2006/2007	466000	258	120228000
2007/2008	415000	546	226590000
2008/2009	430000	500	215000000
Average	396200	401	158598600
2009/2010	280000	360	100800000
Loss in revenue in 2009/2010			57,798,600

Source: CGC (2008-2010), Government of Saskatchewan (2010)

However, for the decline in price and quantity exported of flaxseed in 2009/2010 there may be other reasons than the CDC Triffid event. Therefore, attributing the $57 million decrease in revenue in 2009/2010 solely to the CDC Triffid event was an approximation. However, after the CDC Triffid event, there was an increase in import demand of flaxseed from China which led to an increase in total revenue. The main reason for the change in revenue was the increase in total exports compared to the average export in the previous five years. Even with the reduced price, this high export quantity resulted in a gain in revenue to the industry. As illustrated in Table 5.19 it was $12 331 600 in 2009/2010.

Table 5.19: Change in revenue in total flaxseed exports

Total exports	Tonnes	Price ($/tonne)	Revenue ($)
2004/2005	415000	442	183430000
2005/2006	440000	259	113960000
2006/2007	579000	258	149382000
2007/2008	545000	546	297570000
2008/2009	638000	500	319000000
Average	523400	401	212668400
2009/2010	625000	360	225000000
Gain in revenue in 2009/2010			12,331,600

Source: CGC (2008-2010), Government of Saskatchewan (2010)

From 2004/2005 to 2007/2008 there were only 39 000 tonnes of flaxseed exported to China (7 percent). However, in 2009/2010, 35 percent of Canadian flaxseed had been exported to China (Statistics Canada, 2010f). See Table 5.20.

Table 5.20: Change in revenue in flaxseed export to China

Total exports to China	Tonnes	Price ($/tonne)	Revenue ($)
2009/2010	218750	360	78,750,000
Average	39000	401	15,639,000
Gain in revenue			63,111,000

Source: Author’s calculations, Statistics Canada (2010f)

If there were no exports to China, the flaxseed industry of Canada would have faced a $63 111 000 loss in revenue in 2009/2010. However, it is apparent that China is not a stable market for flaxseed relative to the EU. The main reason for higher import demand of China was the very low prices of Canadian flaxseed in the market.

5.6 Total additional cost associated with CDC Triffid event in the EU

In the EU, flaxseed importers, storers, distributors and oil crushers are those mainly affected by the CDC Triffid event other than consumers. A study conducted by COCERAL and FEDIOL in EU gives rough estimate of the size of the additional cost. COCERAL stands for the Committee of cereals, oilseeds, animal feed, oils and fats, olive oil and agrosupply trade of the EU. The members of COCERAL are the national trade organisations of most of the EU-27 Member States. They represent collectors, distributors, exporters, importers and agribulk storers of the above mentioned commodities (COCERAL, 2010). FEDIOL is a European industry federation representing the European oil and protein-meal industry which is based in Brussels. FEDIOL members crush 30 million tonnes of oilseeds a year (FEDIOL, 2010).

According to the study conducted by COCERAL and FEDIOL (2010), as the available quantities of flaxseed for export from countries other than Canada cannot replace the reduction of Canadian product entering the EU due to the CDC Triffid event, the incident has triggered a market standstill that has caused significant economic losses for the EU linseed market and stakeholders.

Out of the total flaxseed imports of EU, approximately 80 percent is processed by the crushers and the remaining volumes are destined to all other uses (mainly food uses). The EU flaxseed crushing industry is primarily composed of small/medium size companies. Belgian flaxseed operators are mainly equipped to crush only flaxseed and, hence, are not in a position to switch to, for example, crushing rapeseed. If sufficient flaxseed at a competitive price is not available they have no option other than shutting down their operations. The crushers usually obtain about 33 percent crude linseed oil and 64 percent of linseed cake/meal from their operations (COCERAL and FEDIOL, 2010).

COCERAL and FEDIOL (2010) analysed the economic impact of the EU's zero tolerance on CDC Triffid flax. Due to low supplies and additional management costs due to the CDC Triffid event, flaxseed prices in the EU have increased considerably and that has resulted in decrease in profit for the flaxseed crushing industry of EU. Table 5.21 illustrates the estimated extra cost related to handling CDC Triffid positive flaxseed in EU during September 2009 to May 2010.

Table 5.21: Total Additional Cost borne by flaxseed industry of the EU

Cost Category	Cost €
Decrease in profit	1 700 000
Recalled products	2 100 000
Destroyed products	1 300 000
Storage cost (blocked products)	130 000
Customers' claims[48]	18 000 000
Shutting down operations	300 000
Total Additional Cost	23 530 000

Source: COCERAL and FEDIOL (2010)

A large amount of raw material and foodstuffs containing flaxseed (bread, muesli, cookies, etc) had to be recalled. For the traders this entails extra costs related to freight, storage and additional monitoring and sampling plans. As small proportion of food containing flaxseed has been destroyed by the traders. The CA$ value of above Total Additional Cost is $32 000 800[49].

5.6.1 Value of forgone flaxseed imports in the EU

In 2009/2010 the reduction in flaxseed imports of the EU from Canada was 116200 tonnes when compared to average imports of the previous five years (CGC, 2000-2010). To understand whether this amount was imported from any other country, data on total flaxseed imports to the EU was examined using UNcomtrade data. According to that data, total flaxseed imports to the

[48] Cost related to refunds for flaxseed containing food delivered to customers.
[49] 1 € = 1.36 CA$ in 2010 (Bank of Canada, 2010)

EU were reduced by 119944 tonnes in 2009 compare to average total imports over the previous four years, see Table 5.22.

Table 5.22: Trade loss to EU due to low imports in 2009

Year	Total flaxseed imports to EU from the world including Canada (tonnes)	Trade value (US$ million)
2005	478360	193
2006	504150	155
2007	695843	252
2008	449993	323
Average	532086	231
2009	412142	218
Reduction in imports in EU in 2009	119944	63

Source: UNcomtrade (2010)

Therefore, the reduction of flaxseed imports from Canada has not been offset by imports from other countries. COCERAL and FEDIOL (2010) also support that conclusion. By using the estimated total trade loss in the EU in 2009, the loss due to low flaxseed imports from Canada can be estimated.

By using the reduced imports from Canada in 2009, i.e 116200 tonnes and the average price of flaxseed in the EU in 2009, i.e US$529.5 (CA$ 540[50]), the value of given up imports from Canada can be calculated. The value is CA$62 748 000. Therefore, the flaxseed industry of the EU lost flaxseed imports worth of CA$62.74 million in 2009/2010 due to the zero tolerance policy of the EU on GM comingled flax from Canada. However, as there are number of reasons affecting the changes in price and quantity demanded attributing $62.74 million change in imports solely to CDC Triffid flax event was an approximation.

[50] 1 US$ = 1.02 CA$ in 2010 (Bank of Canada, 2010)

5.7 Conclusion

According to the estimations made in this study, the additional cost associated with CDC Triffid event was considerable for the flaxseed industry of Canada. In 2009/2010, if only exports to the EU was considered, the cost was $7.6 million and if total exports to all the countries were considered the cost was $8.3 million. In the case of total exports to all the countries total cost of testing was $1,278,952 and total cost of segregation was $ 4,236,374. However, there is lack of information about the cost borne by number of institutions that play a major role in the flaxseed industry. Further, most of the estimates were based on tolerance level higher than 0.01 percent. Therefore, the total costs given here would be underestimates of the actual cost to the industry.

In 2009/2010 the reduction in exports to the EU caused approximately $58 million loss of revenue to flaxseed industry of Canada. Market uncertainty associated with Triffid flax event may be one of the reasons behind this huge trade loss. The total exports to all the countries have given approximately $12 million worth gain to the industry mainly because of extraordinary exports to China. However, as China is not a stable market for Canadian flaxseed, the best solution would be the restoring the EU market by removing the EU's zero tolerance to CDC Triffid flax.

In 2010/2011, even if flaxseed exports of Canada to the EU return to normal levels, the industry would incur additional costs of approximately $8 million due to the strict regime set by the Protocol. In the case of EU, the additional cost associated with the zero tolerance on CDC Triffid flax was approximately $32 million as of May 2010 and it was greater than the additional cost incurred by flaxseed industry of Canada. Furthermore, the flaxseed industry of the EU lost flaxseed imports worth of $62.74 million in 2009/2010 due to the zero tolerance policy of the EU.

Chapter 6 : Summary and Conclusion

Flax is one of the major cash crops in Canada. Approximately seventy percent of Canadian flaxseed has typically been exported to the EU. In 2009 the EU imposed a trade restriction on Canadian flaxseed due to adventitious presence of GM flax variety - CDC Triffid was identified in Canadian flaxseed in the EU. The impact of the trade restriction was economically harmful to both Canada and the EU. The CDC Triffid event provided the spur for an analysis of the GMO policy of the EU in the context of international trade rules. Both Canada and EU are members of the WTO and have made commitments under the WTO and, in particular, the WTO's SPS agreement. However, they differ over their interpretation of the commitment to market access pertaining to the use of science in the decisions to impose barriers to market access. This leads to the contentious issue of the EU's 'zero tolerance' for GM flax. The EU's decision to maintain zero tolerance on CDC Triffid flax has been justified on the precautionary principle. Precautionary measures are allowed under Article 5.7 of the SPS Agreement in a case where relevant scientific evidence is insufficient. However, according to SPS Agreement precautionary measures are subject to a scientific risk assessment. As the EU did not base its zero tolerance for CDC Triffid flax on any risk assessment the EU is in violation of its commitments under the SPS Agreement. Moreover, the EU has not considered the available scientific information on CDC Triffid flax which were used to give approval to Triffid flax in Canada. The important question is why the EU ignores its SPS Agreement commitment in the case of CDC Triffid flax. In realty, there are number of other reasons which outweigh the scientific reasons in the EU decision-making leading the EU to restrict market access for CDC Triffid. However, the inconclusive nature of science's role in decision-making allows the EU to claim its restriction is based on sound science. A WTO Dispute Panel is the appropriate mechanism to rule on the current EU policy. Furthermore, the non-scientific reasons behind the EU's zero tolerance on CDC Triffid flax expose other dimensions of GMO debate, such as strong consumer resistance to GMOs in the EU.

The estimation of additional costs associated with the CDC Triffid event in 2009/2010 shows that in the case of exports to EU the cost was $7.6 million and in the case of total exports to all the countries the cost was $8.3 million. In 2009/2010 the reduction in exports to the EU caused approximately $58 million loss of revenue to flaxseed industry of Canada. Market uncertainty associated with CDC Triffid flax event may be one of the reasons behind this huge trade loss. The total flaxseed exports to all the countries have given approximately $12 million worth of gain to the industry mainly because of extraordinary exports to China. The significant increase of imports of flaxseed by China acted, in part, to offset the economic loss incur by the Canadian flaxseed industry in 2009/2010. The prices paid by Chinese importers are much lower than those received from the EU buyers. Further, as China is not a stable market for Canadian flaxseed, the best solution would be the restoring the EU market by removing the EU's zero tolerance for CDC Triffid flax. In the case of the EU, for 2009/2010 the additional cost associated with zero tolerance for CDC Triffid flax was higher than the additional cost incurred by the flaxseed industry of Canada.

The reasons behind the EU's zero tolerance on CDC Triffid flax and the additional costs associated with the zero tolerance on flaxseed industry highlight the importance of further analysing of GMO policies carefully. Even though new GM crops will increase productivity the absence of harmonised GM policies among countries will jeopardise the potential benefits of GM crops. The ambiguity associated with the scientific rationale of SPS measures has made it relatively easy for countries to misuse science when they need to deny market access for certain GMOs.

Limitations of the thesis

Time and budget were the main limitations of this study. If more time was available a more comprehensive review of the use of science in SPS Agreement could have been undertaken. If such a review was done it would be a valuable basis for the further development of a scientific rationale for the SPS Agreement. If more resources were available for the study, more traveling would have been done to collect more data related to the estimation of the total additional cost of zero tolerance, not only in Canada but also in the EU as well.

Areas of further research

This study can be expanded into three areas of further research. First is a comprehensive analysis of the root causes behind the non-scientific rationale of the EU's decision making process regarding GMOs. The second area is studying the possible ways of harmonising the international trade rules in the case of trading of GMOs. In this area of research, possibilities of strengthening the SPS Agreement can be studied. As GMOs are a new innovation, how to incorporate them into SPS Agreement in a precise way is a worthy area for further research. The third area is conducting a producer survey to estimate on farm costs of testing and segregation related to the Triffid event.

Contribution of the thesis

There are two main contributions of this thesis. First is the analysis of the EU's GMO policies used to disrupt Canadian flax exports which indicates that they are not compliant with the EU's SPS obligations. The second contribution is the estimation of total additional cost and changes in revenue associated with the operationalisation of zero tolerance policy of the EU. Furthermore, LLP of GMOs is a growing concern in international trade. Therefore, this study will contribute as a case study useful for the future trade disputes related to LLP of GMOs.

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